POWER TOPICS CROSS-INDEX

STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
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POWER MISCELLANY

VOLUME 83 NUMBER 1

POWER

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JANUARY, 1939

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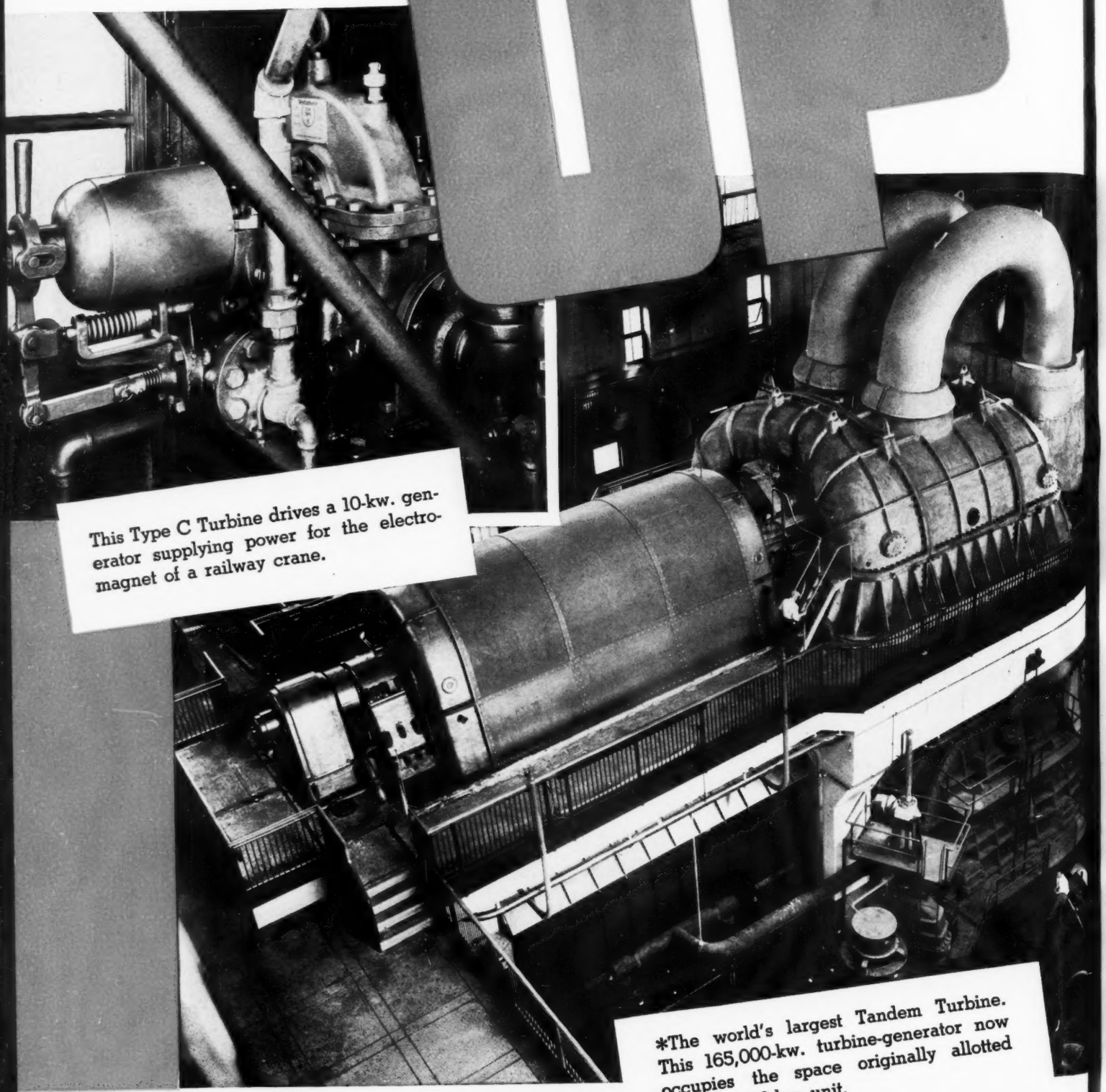


This Type C Turbine drives a 10-kw. generator supplying power for the electromagnet of a railway crane.

*The world's largest Tandem Turbine. This 165,000-kw. turbine-generator now occupies the space originally allotted for a 60,000-kw. unit.

Westinghouse *Complete*

POWER

Established 1882 PHILIP W SWAIN, Editor

A Man Speaks Out

IT TAKES a lifetime to perfect an engineer, but his framework—whether it be that of a man or a milksop—is forged while the iron is hot, in the plastic years between birth and twenty-one. It's then, or never, that most men learn how to think. And it's then or never that most engineers must lay the foundation of their practical experience.

Perhaps you are sending your boy to college, so he will have "his chance." Fine, but don't let him get the idea that he can snuggle safely in the swaddling clothes of parental and academic protection until he's a grown man of twenty-two, with an engineering degree in his pocket. Long before that he should start working on real jobs with real machines, rubbing elbows with men of flesh and blood, facing actual responsibilities.

POWER has said this before, and will say it again, because it's the most important problem facing engineering education. Now comes confirmation from a man in England who very likely never heard of our views. Stephen Fletcher, Managing Director of E A Gardner and Sons, Ltd, Maidstone, England, speaks his mind in a recent letter to the editor of *"The Engineer"* (London). Let's quote the high spots:

"I have contended . . . that the system was all wrong. . . . They have gone right off the old method of training real engineers . . . have developed a system . . . which sends out into the world young men fitted only to sit at a desk . . . and who, if confronted with the slightest thing 'different,' go all to pieces, helpless and hopeless.

" . . . as the years rolled on I was put to the test, for I had a son whom I was determined should become . . . a better engineer than his old father. That son had reached the age of seventeen. . . . Should he go on to the university and complete his education there before getting down to 'work,' or face up to two or three years of hard slogging and hard study on a . . . 'mixed grill' course?

"The work course . . . triumphed. My boy was articled to my own firm. . . . By the time he was ready for his B Sc final examination, he knew how to hold a hammer and file and use them, could operate any machine tool in the shop . . . could design a job, draw it, see it through pattern shop, foundry, machine and fitters shop and then 'cost it out,' could talk to employees on their own level and retain his own without swank. And then, at twenty, he passed that examination in London.

"I told him . . . 'you can now have a tryout by taking charge of the works while I take a holiday.' The tryout was successful. . . . At the age of twenty-one . . . I appointed him . . . Works Manager. Only a little provincial engineering works, thirty employees . . . but all of the departments of the big works in miniature.

"Now the lad is twenty-six . . . he is the manager, the boss, and my employees accept his authority without question, and he carries his responsibility without strain, swank or fuss. He is a better man at the job now than I was at thirty-nine . . . because his method of training taught him to be a mechanic, to see and feel engineering at its very heart's core . . . because at the age of seventeen to eighteen he began to get training in responsibility simultaneously with his mechanical training and his engineering education. He did not have responsibility thrust upon him suddenly, as so many of the young experts have today, only to collapse into those 'minor posts.'

" . . . my favorite place is still on my feet at the long bench, with a drawing board atop, and that is where I'd like to see our young engineers in spirit and in fact, on their feet and able to stand alone on them. Polished desks . . . are no training for a young manager. There is only one place to teach him management and that is among the men and machines he is going to manage.

" . . . I would teach the young man to be . . . an engineer with his head, a craftsman with his fingers, a mechanic in his heart, to remain always a student. I would have a leader who could, and would lead and manage, not 'handle' the whole of his personnel. . . . Experience would then give the rest, and the years would bring wisdom.

"I am one of the 'Old Timers,' one of those whose training and experience came in the hard struggle and toil of employment from boyhood to youth, youth to manhood, manhood to middle age and so on into my own business. . . .

"The 'Big Ones' will confer, appoint committees, evolve schemes. Employees will ask for their 'trained men,' but no one will represent the young men trained in the harder school of the small general engineering works and the technical school, plus the university, who, I shall claim to the last, are the best engineers and the best men."

These words of Stephen Fletcher are the voice of wisdom. To them I can add nothing but my humble and heartfelt "Amen!" —PHILIP W SWAIN

Essex Tops at 1250 Lb, 950 F

*Six years' experience with Burlington superposed unit provided the background for design of Essex's new 50,000-kw, 1250-lb, 950-F top**

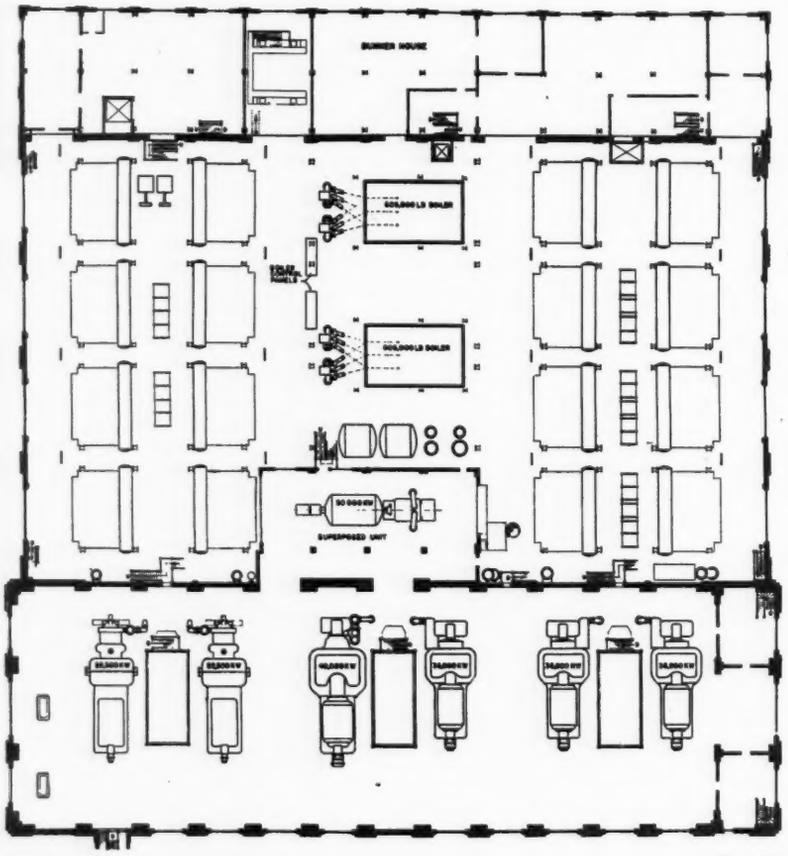


Fig. 1—Plan view of station showing new boilers in center section of boiler house and high-pressure turbine in newly partitioned bay

AFTER SEVERAL YEARS operating experience with a 650-lb, 850-F superposed unit at the Burlington Generating Station of the Public Service Electric and Gas Company, New Jersey, investigation indicated a 50,000-kw top at Essex Generating Station to be the most economical way of adding capacity to the system. Needed for the 1938 winter peak, the first boiler was placed in operation May 28 and the turbine synchronized with high-pressure steam July 12, 1938.

Progress in the development of metals suitable for high-temperature steam service has made possible superposition at 1250 lb without reheat. Studies of a wide range of heat balance possibilities showed that the highest practical steam temperature would be economically justifiable because of the ability of existing low-pressure turbines to use 225-lb exhaust steam at a temperature as high as 650 F.

The original station contained six main units ranging from 22,500 to 40,000 kw, totaling 193,000 kw. Heat balance was obtained by varying the number of steam and motor-driven auxiliaries in

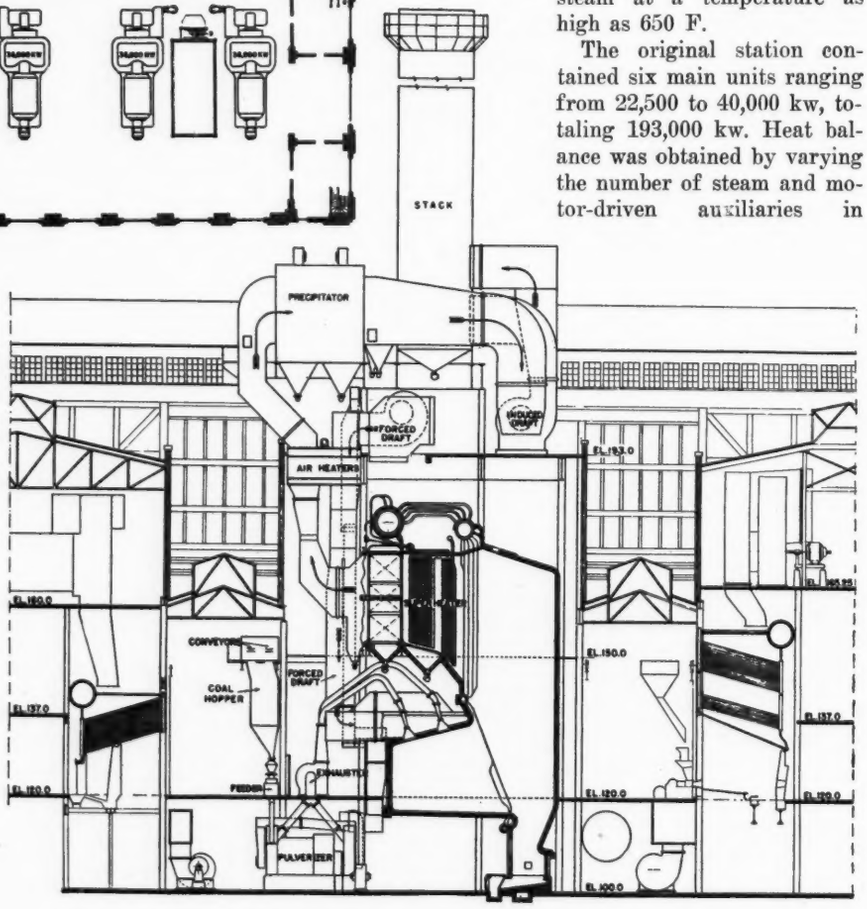


Fig. 2—Cross section of boiler unit shows primary furnace, slag screen, secondary furnace, only four rows of what used to be considered boiler tubes, superheater and economizer sections. Fans and precipitators are above roof level, outdoors

* From a paper presented by H Weisberg before the Metropolitan Section of the ASME, Nov 17, 1938. A report of early operating experiences at Essex will appear in February POWER.

operation to heat feedwater to 214 F. Ten of the original 24 underfeed-stoker-fired boilers had been converted to oil burning.

Unusual among modern topping installations, the new turbine and boilers are located in the center of the boiler house. This allowed removal of eight boilers without sacrificing the newest and largest at the south end nor older ones at the north end which are equipped for oil burning and therefore are better suited for standby service.

The new turbine can supply any of six 225-lb condensing turbines through the existing station steam header, carrying a total of about 70,000 l-p with 50,000 h-p kw. Two of the newest 36,000-kw low-pressure turbines are sufficient to take the entire exhaust of the high-pressure unit, but best station economy is obtained with three in operation. Two reducing and desuperheating bypasses assure that not over 60,000 kw will be dropped by the loss of either high-pressure boiler or the turbine.

For some time to come, the new unit will run as a base-load machine, with the exhaust pressure being regulated either by low-pressure boilers or by varying load on the low-pressure units. A backpressure governor is provided, however, for expected future conditions when the unit may be required to regulate frequency.

As a result of superposition, about half the station's present 243,000 kw is efficient base-load capacity and about half serves as standby. Interconnections are sufficient to allow economy operation at full load on the new unit except for a small percentage of time during low-load periods when excess hydro power is available.

Additional cost for providing the required boiler capacity in two units instead of one is believed to have been a good investment because of greater availability and certain operating advantages. Only one forced and one induced-draft fan per boiler are provided, whereas with a single boiler arrangement two of each would have been mandatory on account of size if for no other reason. Also only two mills serve each boiler, a simpler arrangement than would have been satisfactory for a single boiler.

Turbine-Generator

The turbine is of double-casing construction arranged so that the maximum pressure between casings is about 400 lb at a temperature considerably below throttle conditions. Part of the pressure and temperature differential between the inside of the shell and atmosphere is thus carried by each of two joints.

Four valves admit steam ahead of the first of the turbine's 12 stages; two overload valves bypass the first two stages. Control valves are separate from the turbine shell to reduce strains from temperature changes and gradients and are accessible for repairs with the turbine-room crane. Three valves are on each side of the turbine at the floor level with bonnets and moving parts above the floor. Inlet piping and emergency stop valves are below the floor, but internal parts of the valves, which include the strainers, are accessible from above through hatches and removable covers.

Governing can be from speed, backpressure or by fixed throttle. Last stage differential-pressure protection is provided to limit throttle flow in case of extreme drop in backpressure. There is also a motorizing relay in the generator circuit which trips the generator breaker if reverse power flow exceeds 345 kw for more than one minute. This protects against overheating if steam flow is too low to keep turbine blades cool.

The 50,000-kw, 0.9-p f generator has four hydrogen coolers built into the shell parallel to the shaft. River-water pressure on these coolers is maintained slightly below atmospheric by a down leg on the discharge so that water cannot leak into the hydrogen space.

Gear-driven exciter and pilot exciter run at 1775 rpm to limit centrifugal forces on their commutators. They are totally enclosed and provided with a surface air cooler.

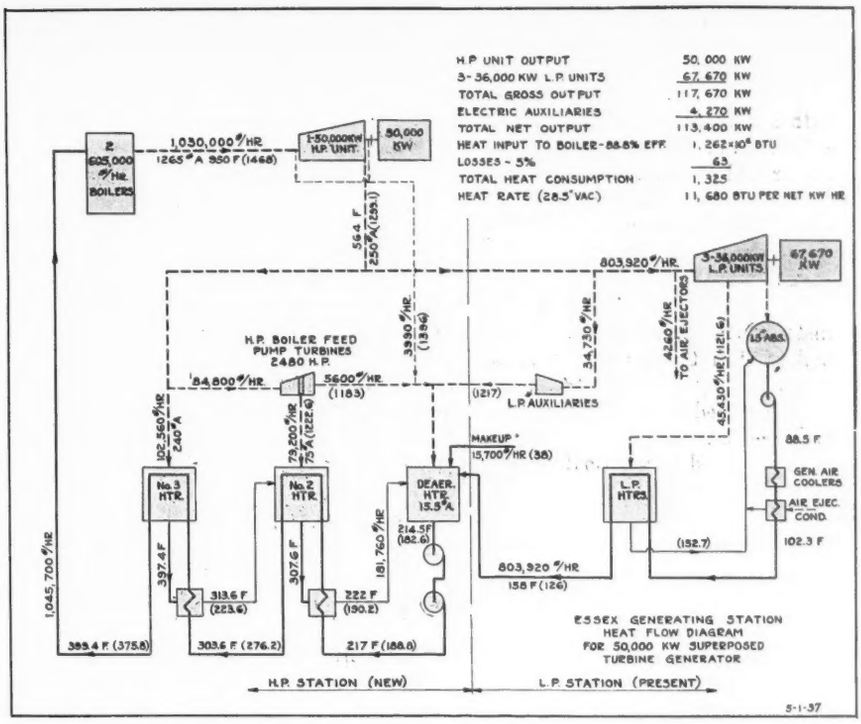


Fig. 3—Boiler-feed-pump turbine exhaust and steam from other auxiliary drives supply deaerator. Bleed from boiler-feed-pump turbine heats feed to about 300 F

To avoid fire hazard, turbine-oil reservoir and pumps are installed on the exciter end. All pressure-oil pipes run inside return lines. The oil operating cylinder for the governor valves is inside the No. 1 turbine pedestal; control valves are operated through mechanical linkage. Direct mounted oil cylinders on the emergency stop valves are below the valve bodies so that an oil leak would drip away from the high temperature parts.

Steam Generators

The boilers fire either pulverized coal or fuel oil. Coal with a grindability as low as 50 (Hardgrove scale), a maximum ash content of 11%, moisture 10%, and ash fusion 2100-2600 F may be fired although normal coal is Pennsylvania or West Virginia slack with high grindability and low ash content. A limited amount of low-grade anthracite may be fired in combination with oil. With normal coal, the mills have a capacity 135% of full-load boiler output. An exhauster removes the coal from the mill and blows it directly through intertube burners into the furnace.

The boilers are of special design to minimize slagging of the heating surfaces. Preliminary investigation indicated that successful operation at high steam temperature requires maintaining an even distribution of gas through the superheater. Slag causes stratification of the gas, increased velocity and local overheating. Expected long periods of operation at full-load inten-

sify the importance of the slag problem. Study indicated also that the size of unit affects slagging characteristics, a larger furnace having less furnace wall relative to furnace volume with attendant higher gas temperature entering the convection surface. This factor had considerable bearing on the choice of two smaller boilers instead of a single large one. A conservative heat release of 27,000 Btu per cu ft per hr was decided on.

Investigation of a number of typical installations indicated that bent-tube boilers with tubes nearly vertical had less tendency to slag and were more easily cleaned than the nearly horizontal tubes of straight-tube designs. Firing downward also probably results in less slag.

Operation at Burlington indicated the need for lancing furnace walls to maintain uniform superheat. With clean walls, lower and more uniform gas temperature entering the superheater can be expected. It was specified that provision be made in the furnace walls for slag blowers.

The arrangement of the boilers chosen based on the foregoing considerations is essentially the bent-tube type and differs from usual only in that the boiler proper is practically eliminated, heating surface consisting mostly of water walls. A furnace slag screen forms a division between primary and secondary furnaces. Then four rows of widely spaced tubes precede a pendant-type superheater. Downcomer tube banks and mud drum are eliminated. Two 20-in. downcomers distribute to the lower water-wall headers.

A number of features of the unit make for low first cost. The furnace is narrow, 22 ft, and output per foot of drum length is high. The single-pass arrangement permits low gas velocity entering the convection surfaces, 25 ft per sec, even with the narrow furnace width. Tubes 80-ft long without intermediate headers and tube-to-tube type walls make for economical construction of the furnace.

Draft loss is low because of the low convection-surface entrance velocity and the absence of baffles with the single-pass arrangement.

Slag drains continuously from the primary furnace over a ledge into a

Principal Equipment—Essex Station, Superposed Unit

PUBLIC SERVICE ELECTRIC AND GAS COMPANY, NEWARK, N. J.

Steam Generating Equipment:

Boilers and water walls.....Babcock & Wilcox Co
2 radiant boilers; heating surface, including water walls—10,670 sq ft with slag screen, 9,507 sq ft without slag screen; maximum continuous steaming capacity, 605,000 lb per hr; working pressure, 1475 lb g, total steam temperature 950 F; furnace volume 27,800 cu ft; heat liberation at maximum continuous steaming capacity, 27,000 Btu per cu ft per hr.
Superheaters, 17,450 sq ft, counterflow.....Babcock & Wilcox Co
Economizers, 16,090 sq ft, counterflow.....Babcock & Wilcox Co
Air heaters, 2-36,800 sq ft, Ljungstrom, per blr.....Air Preheater Corp
Boiler and furnace setting.....Babcock & Wilcox Co
Ash hopper.....Allen-Sherman-Hoff Co
Furnace refactories.....{M H Detrick Co / George Allen & Son}
Boiler insulation.....Charles S Wood

Boiler Auxiliary Equipment:

Coal pulverizers, 2-33,000 lb each per blr.....Foster Wheeler Corp
Hardinge type, double-classifier tricone ball mills
Pulverizer drive motor.....Allis-Chalmers Mfg Co
Constant speed, 300 hp, 360 rpm, 2400 volts
Coal feeders, 2 per blr, 29-in., table type.....Foster Wheeler Corp
Coal feeder drive motor.....Westinghouse Elec & Mfg Co
Constant speed, 1 hp, 1200 rpm, 220 volts
Mill exhausters, 2 per blr, constant speed.....Foster Wheeler Corp
Mill exhauster driving motor.....Allis-Chalmers Mfg Co
Constant speed, 100 hp, 1200 rpm, 2400 volts
Forced-draft fans, vane control, one per blr.....B F Sturtevant Co
185,000 cfm at 120 F, 11 in. wg, 870 rpm
Forced-draft fan drive motor.....Westinghouse Elec & Mfg Co
Constant speed, 870 rpm, 500 hp, 2400 volts
Induced-draft fan, vane control.....B F Sturtevant Co
320,000 cfm at 360 F, 11 in. wg, 870 rpm
Induced-draft fan drive motor.....Westinghouse Elec & Mfg Co
Two speed, 870 and 690 rpm, 1350 hp, 2400 volts
Ducts and breeching.....Connery & Co
Coal burners, 6 per boiler, intertube.....Babcock & Wilcox Co
Oil burners, 12 per boiler.....Babcock & Wilcox Co
Soot blowers, one boiler.....Bayer Co
one boiler.....Diamond Power Specialty Corp
Automatic combustion control.....Hagan Corp
Water columns.....Yarnall-Waring Co
Gage glasses.....Diamond Power Specialty Corp
1 Bi-color and 1 direct-sight type per boiler
Flash-tank level controller.....Bailey Meter Co
Chemical feed pump.....Worthington Pump & Mach Co

Coal Handling Equipment:

Coal conveying equipment.....Robins Conveying Belt Co
Coal conveying equipment drives.....Westinghouse Elec & Mfg Co
Coal scales, 2 weightometers.....Richardson Scale Co

Ash Handling Equipment:

For furnace slag.....Allen-Sherman-Hoff Co
For dust from precipitator and breeching.....Allen-Sherman-Hoff Co
Precipitators, 2 Cottrell, rod-curtain per blr.....Research Corp

Feedwater System:

Deaerators, 2—650,000 lb per hr each..Worthington Pump & Mach Corp
Feedwater heaters.....Foster Wheeler Corp
1—225-lb steam pressure, 4000 sq ft surface, vertical
1— 65-lb steam pressure, 6075 sq ft surface, vertical
Arsenical copper tubes, 2000-lb pressure in tubes and heads
Heater drain coolers.....Foster Wheeler Corp
1—225-lb pressure, 572 sq ft surface, vertical
1—65-lb pressure, 1158 sq ft surface, vertical
Arsenical copper tubes, 2000-lb pressure in tubes and heads
Heater drainage controllers.....Stets Co
Boiler water treatment.....Cyrus Wm Rice & Co
Primary boiler-feed pumps.....Worthington Pump & Mach Corp
2—new, 1— rebuilt, 1360 gpm each, 484 ft head
Primary boiler-feed pump drives.....Westinghouse Elec & Mfg Co
2 constant speed motors, 250 hp, 1758 rpm 2400 volts
1 constant speed reconditioned turbine, 300 hp, 2200 rpm
Secondary boiler-feed pumps.....Worthington Pump & Mach Corp
3—capacity 1360 gpm each, 3800 ft head
Secondary boiler-feed-pump turbines.....Westinghouse Elec & Mfg Co.
3 variable-speed, 1900 hp, 3570 rpm, automatic bleeding
Feedwater-pressure control equipment.....Republic Flow Meters Co
Feedwater level regulators, 3-element control.....Bailey Meter Co

Piping Systems:

High-pressure fabricated piping.....M W Kellogg Co
Intermediate- and low-pressure piping...{M W Kellogg Co / Midwest Piping & Supply Co}
Boiler safety valves.....Consolidated Ashcroft Hancock Div
5 drum, 2 superheater, 3-in. valves per boiler
Intermediate-pressure safety valves...Consolidated Ashcroft Hancock Div
8- 6-in. for turbine exhaust, 8- 6-in. for reducing stations
Blowdown valves, 3 per boiler.....Yarnall-Waring Co
Non-return valves, 12-in. angle type.....Schutte & Koerting Co
Steel gate valves.....Crane Co
Steel globe and check valves.....Edward Valve & Mfg Co
Iron gate, globe and check valves.....Reading, Pratt & Cady Co
Pressure-reducing and desuperheating valves.....Schutte & Koerting Co
2—8-in. by 18-in., capacity, 600,000 lbs per hr
Desuperheating-station valve control.....Hagan Corp
Turbine-exhaust desuperheater.....Schutte & Koerting Co
4 cam-operated valves, 8 spray nozzles
Turbine-exhaust desuperheater control.....Hagan Corp
Valve operators, Limitorque.....Philadelphia Gear Works
Heat insulation, piping and auxiliaries.....H W Porter Co
Johns-Manville material
Pipe hangers, constant-load, Genspring.....Grinnell Co
Traps.....Yarnall-Waring Co
Welding electrodes.....Metal & Thermit Corp

Meters and Instruments:

Boiler meters, recorders and draft gages.....Bailey Meter Co
Temperature recorders.....Leeds & Northrup Co
Fuel-oil and water meters.....Neptune Meter Co
Tank-level indicators and recorders.....Taylor Instrument Co
Indicating flow meters.....Taylor Instrument Co
Integrating flow meter.....Leeds & Northrup Co
Condensate conductivity recorder, 6-point.....Leeds & Northrup Co
Portable conductivity indicator.....Leeds & Northrup Co
Turbine speed recorder.....General Electric Co
Hydrogen and CO_2, purity indicator.....Chas Engelhard, Inc
Industrial indicating thermometers.....Taylor Instrument Co
Pressure gages.....{Consolidated Ashcroft Hancock Div / Ashton Valve Co; Foxboro Co}

Service Equipment:

Turbine-room crane.....Whiting Corp
Boiler-room elevator.....Atlantic Elevator Co
Fire-fighting equipment.....Walter Kidde Co
Air compressor for combustion control.....Ingersoll-Rand Co
Feedwater storage-tank pumps.....Ingersoll-Rand Co
Gland-seal pumps.....Ingersoll-Rand Co
Drip-tank pump.....Goulds Pumps, Inc
Salt-water pumps.....{Delaval Steam Turbine Co / Ingersoll-Rand Co}
Turbine-oil purification equipment.....Delaval Separator Co

Generator Unit:

Turbine-generator.....General Electric Co
One 50,000-kw, 3600-rpm turbine; throttle steam conditions 1250 lb, 950 F; exhaust, 235 lb g
One 55,555-kva, 0.90-p-f, 3-phase, 60-cycle, 13,200-volt 3600-rpm generator
One 185-kw gear-driven main exciter, 1775 rpm
Oil coolers, hydrogen coolers and detraining equipment

water-filled ash pit eliminating hazardous tapping and the formation of a slag pool of any depth. Ash from the dry-type secondary furnace falls into the same pit.

A gas bypass is provided around the superheater for steam temperature control, the gas passing through a section of economizer. The economizer is arranged with vertical headers to obtain counterflow of water and gas with the horizontal gas flow. The tubes pull out of one side of the boiler casing like the drawers of a chest and it has been found that this arrangement permits easy removal of elements for repairs.

Rotating-element air heaters were chosen as experience in other company plants previously has shown this type is desirable for firing coal and oil interchangeably. Accumulated soot can be readily washed off the heater elements. While replacements due to corrosion may be more frequent than with other types, less expense is involved and renewals can be made in a comparatively short time. Butterfly dampers on inlet and outlet of air and gas ducts permit washing one of the two heaters per boiler at a time without taking the boiler out of service. A double damper on the outlet air side forms a seal for introducing cold air from the forced-draft fan discharge. Hoppers are provided for catching drain water.

Boiler Auxiliaries

Forced- and induced-draft fans, air preheaters and precipitators are mounted outdoors above the boiler-house roof, fan motors and controls, however being located in a pent house isolated from the boiler room. Air for combustion can be taken from the top of the boiler room, outdoors, or the motor room. Outdoor arrangement greatly simplifies the ventilation problem of the boiler house, without objectionable effect on the building architecture. The equipment is fortunately nearly hidden by the bunker house on one side and the turbine building on the other.

Single-speed induction motors drive the vane-controlled forced-draft fans, two-speed for the induced. A spare motor of each type is provided. Electrostatic precipitators are of the rod-curtain type.

On one of the two boilers the furnace slag screen has been omitted to determine if it has any value. It is claimed that the screen shields the ash particles in the upper part of the furnace from the radiant heat of the hot burner zone, making them less sticky.

Heat balance arrangement and feedwater pumping system were chosen for simplicity as well as reliability and economy. Studies showed a heater at crossover pressure and one at about 65 lb g, were needed. The three boiler feed pumps are therefore turbine driven at 225-lb throttle pressure with most of the steam flow extracted at the 65-lb pressure, under control of automatically operated grid valves. Excess steam to supply pump power passes through additional stages in the drive turbine to the 1-lb g header supplying the deaerators.

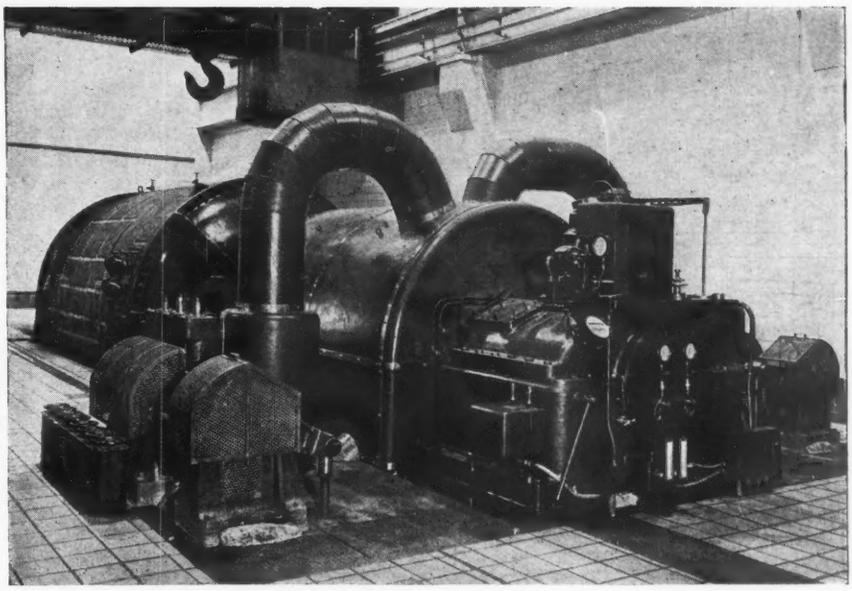


Fig. 4—50,000-kw double-casing hydrogen-cooled turbine-generator

Remainder of deaerator supply comes from other auxiliary exhaust; a balance is maintained by varying the number of steam-driven and motor-driven auxiliaries in service. Condensate from the low-pressure machines is returned to deaerating heaters, two of which supply the new boilers. Two surge tanks take the variations in condensate flow. No evaporators are provided, raw water being introduced into the low-pressure boilers for makeup. Low-pressure boilers will normally operate enough of the time to provide sufficient condensate for the high-pressure boilers with the aid of an 80,000 gal. storage reserve.

Because of the limited head developed by the existing condensate pumps, deaerators are only 20 ft above the pump cellar necessitating a two-stage pumping arrangement. One old steam-driven pump and two new motor-driven units make up the primary stage.

These primary pumps take water from the deaerators and supply the 1600-lb secondary pumps at 300 lb. The two closed heaters, 65-lb and 225-lb are equipped with drain heat exchangers. These heaters are on the discharge side of the secondary feed pumps to avoid numerous hotwater pumping difficulties that have been experienced in other plants. The reducing valves bypassing the high-pressure turbine are of the single-seated type, provided with pistons for balance. Desuperheating water is introduced between two halves of the valve seat and is controlled by a cam on the reducing-valve stem. Flow is readjusted by a thermostat through an air operated regulator.

Performance

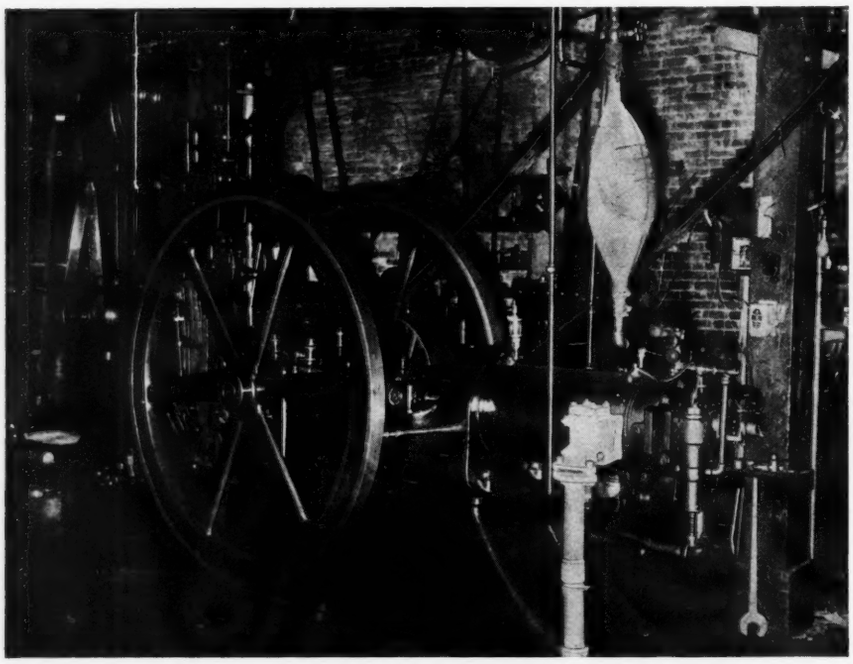
The theoretical heat balance indicates an overall heat rate better than 12,000 Btu per kwhr applying to 120,000 kw of the total station capacity. Actual station heat rate will depend on what proportion of low-pressure equipment is operated. While no attempt has yet been made to attain maximum efficiency, preliminary results indicate performance close to that expected.

This installation has been made primarily to provide additional capacity for the Public Service system in keeping with a general plan of development and consistent with reliability, economy and safety. Available equipment has been utilized to the fullest possible extent and advantage has been taken of latest advancements in materials and equipment. Selection and arrangement of equipment fit local requirements; reasons for some of the decisions will not necessarily apply to other installations. Design of the installation was carried out by the Electric Engineering Dept of the Public Service Electric and Gas Company, and construction work by United Engineers & Constructors, Inc., Philadelphia.

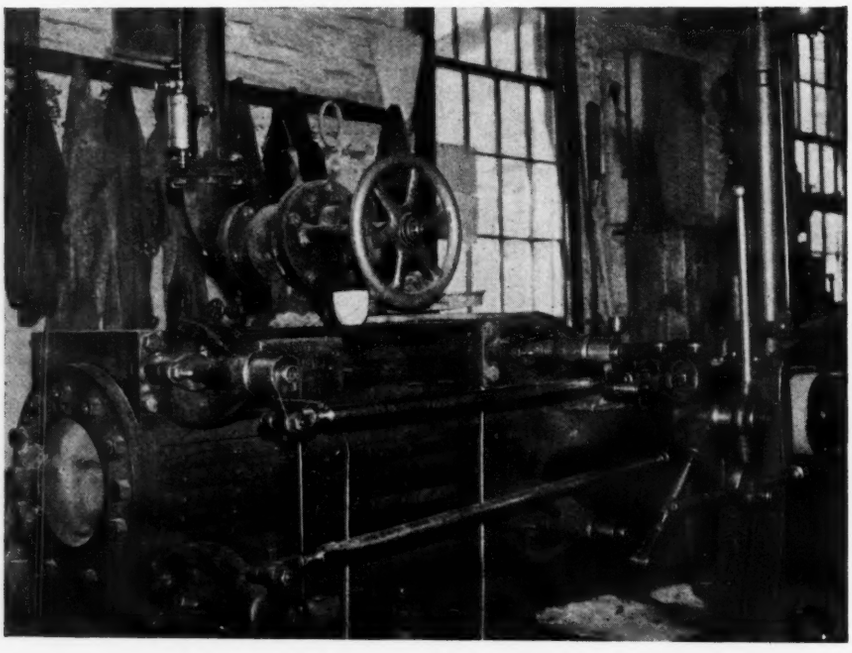
Other photographs of the new Essex installation are on page 81.

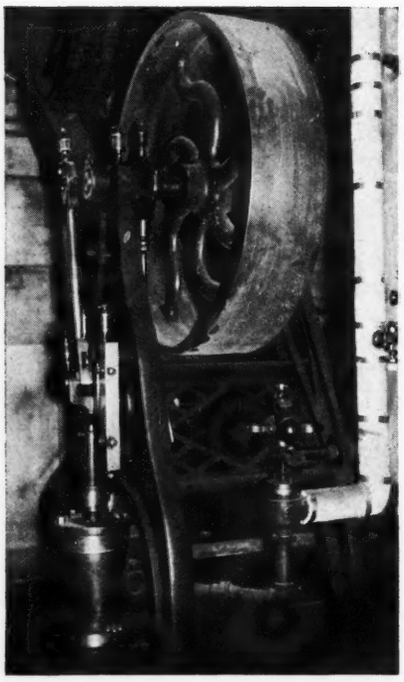
Still Going Strong

POWER VETERANS outside of museums are rare in this fast-moving country where "bigger and better" equipment constantly crowds out units still mechanically sound. Occasionally the economic fates which control such matters are kind and a stouthearted machine is allowed to go on doing an honest job until honorably retired. Here are three such veterans—all actively in harness, still going strong at the task of producing power.

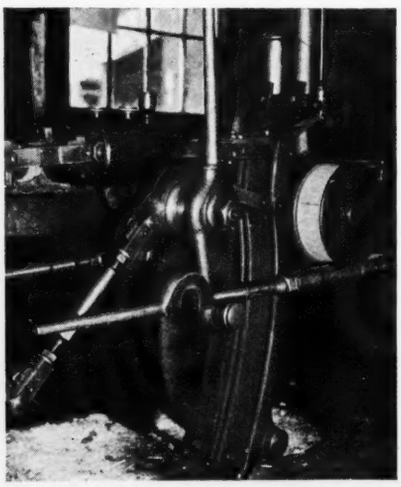


Youngest of the trio is this 50-year-old Otto gas engine, still driving lineshafting at the W B Cobb Machine Shop, Cleveland, Ohio. Although dating back to the infancy of the gas engine, this horizontal single cylinder, 8½x14-in., 250-rpm unit runs daily, burning natural gas as fuel





Backing up a water wheel when water is low, is the job of this vertical steam engine in the Hildreth Bros shop, Harvard, Mass. Built by Clark & Knight of Worcester, its exact age is unknown



Said to be the oldest Corliss engine in use, this veteran serves as low-water standby in the old plant of the L W Phelps Estate, Ayer, Mass. The closeup shows the unusual valve gear, which preceded the familiar wrist-plate and dashpot mechanism. Leaf springs snap the valves closed; the small cylinders in the foreground are not dash pots but guides for the intake-valve rods

Redesign of staybolt and new method of replacement save $10,000 by permitting repair of box-header boiler without removing tubes

Staybolt Replacement

By C D REID*
Chief Engineer,
Oklahoma Gas & Electric Co

A HYDROSTATIC TEST on our No. 4 box-header type boiler disclosed forty cracked or broken staybolts. The conventional method of replacing staybolts by riveting ends would have been very costly. The purpose of this paper is to explain an unusual type of staybolt used in repairing this boiler which resulted in a saving of more than $10,000. There are innumerable installations of box-header type boilers, therefore it seems likely that the method of staybolt repair used on this particular boiler would be applicable to other similar boilers.

Seven of the nine boilers installed at this station are box-header boilers. These boilers have a maximum steaming capacity of 75,000 to 150,000 pounds of steam per hour at 300 lb pressure.

A hydrostatic test made on No. 4 boiler, December 22, 1937, revealed that 39 staybolts in rear box-header and one in front box-header were leaking through tell-tale hole in outer end of staybolts. These staybolts are 1½ in. in diameter and 12 in. long. Fig. 1 shows layout of tubes and staybolts in box-headers. The 39 defective staybolts in rear box-header are indicated on this sketch.

To have replaced these staybolts in the conventional way would have necessitated cutting out most of the steamer tubes in order to use a riveting hammer on inner ends of staybolts. Furthermore, if this method of installation had been resorted to, it would have been most advisable to remove all 316 steamer tubes and replace all 820 staybolts to prevent a similar occurrence making necessary the removal of more steamer tubes.

Removal and replacement of all steamer tubes and all staybolts would have cost in excess of $12,000. Whereas, by employing the uniquely designed staybolt described herein, it was possible to replace the broken or cracked staybolts without the removal of a single steamer tube, at a cost of approximately $2,000. This resulted in a saving of approximately $10,000.

Nature of Staybolt Failure

Removal of a number of defective staybolts showed that transverse cracks in staybolts occurred in about the center of handhole sheet. Factory riveting of ends of staybolts swelled approximately the first three threads on outer end of staybolts to a tight fit in sheet. Cracks occurred, in most instances, just back of these first three threads as shown in Fig. 2. Tests and micrographs of several specimens of the cracked staybolts indicated that failure was not characteristic of caustic embrittlement but was probably due to fatigue and improper installation procedure.

Design and Installation

After much thought had been given the problem, it was decided to make a special tapered tap to run through tube sheet from furnace side and tap threads in tube sheet on a taper of ¾ in. to the foot. Then make a staybolt with a similarly tapered thread at one end. Staybolt to be screwed in through both sheets from furnace side until tapered threads were tight in the tube sheet. Outer end of the staybolt to be fitted with washers and nut.

Fig. 3 shows design of special staybolt which meets the ASME code requirements and has the approval of the State Boiler and Insurance Company authorities, as well as representatives of the boiler manufacturer. Center section of staybolt was turned down and threads omitted to simplify construction. A square section was machined at outer end of staybolt for use in tightening staybolt in tube sheet. Fig. 4 shows a completed staybolt.

All of the 40 cracked staybolts were removed by being cut off next to each

*This paper won a McGraw prize for 1938, sponsored by the Edison Electrical Institute. While it has already appeared in the EEI Bulletin, we think it of sufficient interest to POWER readers to republish in full.

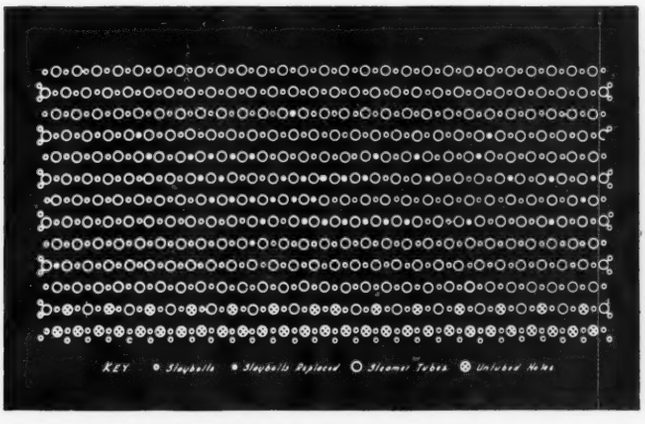


Fig. 1—Tube and staybolt layout of rear header showing staybolts replaced

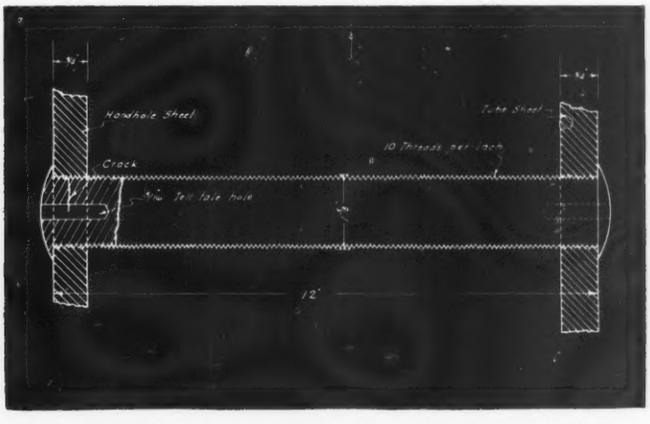


Fig. 2—Sketch of original staybolt showing crack at handhole sheet

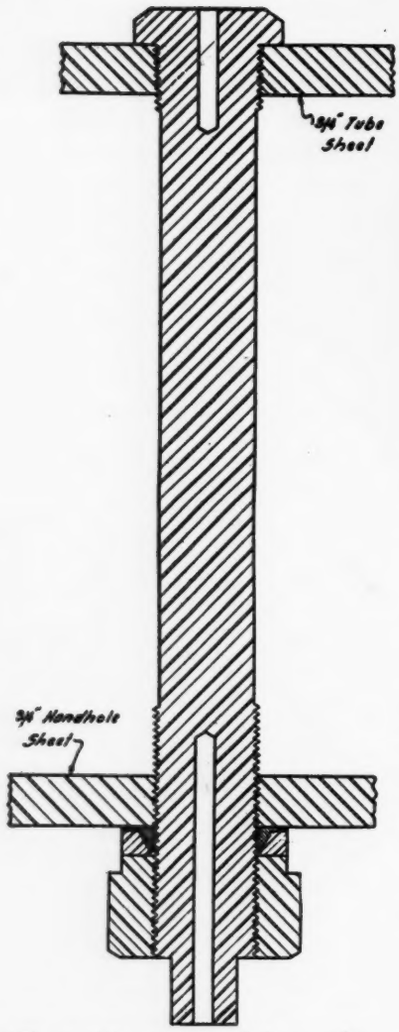


Fig. 3—New type staybolt assembly

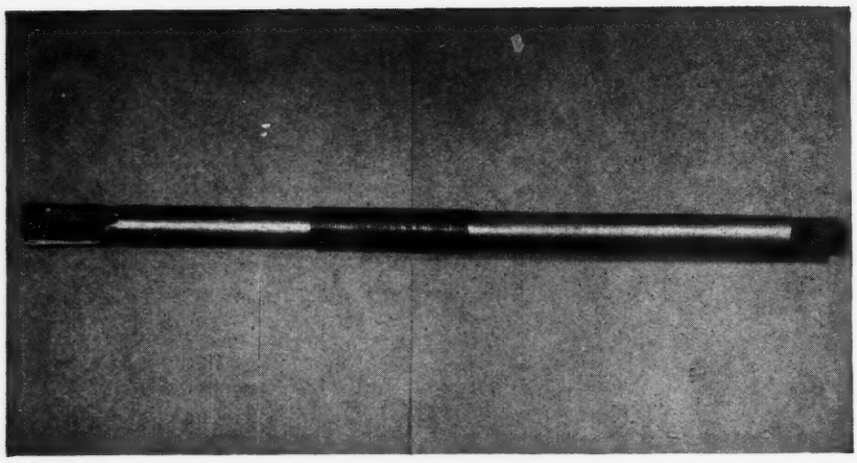


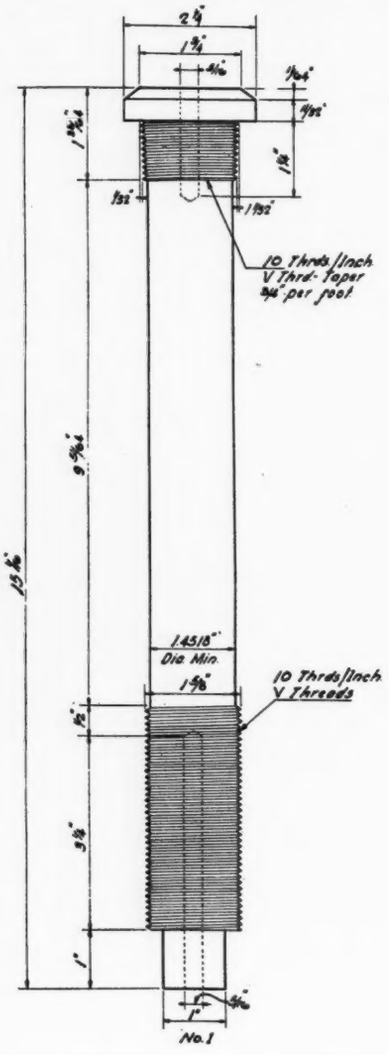
Fig. 5—Special tap

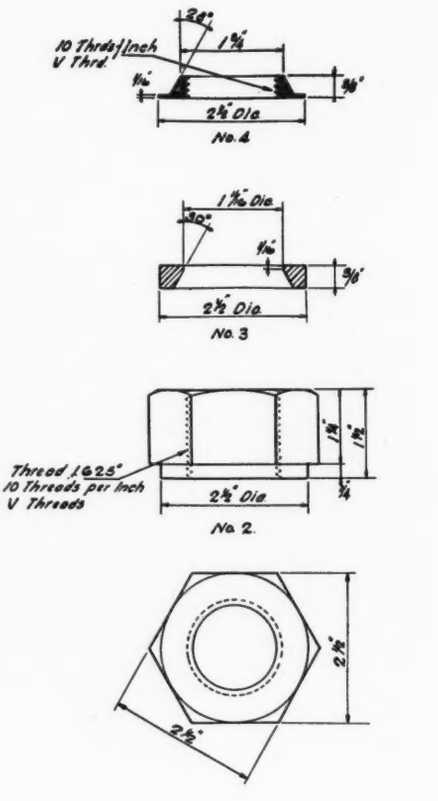
sheet on inside of box-headers with acetylene torch. Drilled 1¼-in. holes in remaining plugs and knocked out threaded shells. Threads in sheets were in fair condition, but were slightly out of pitch, due probably to stretching of the original staybolts.

Fig. 5 shows special tapered tap used to tap tube sheet. Guide threads on tap kept threads in the two sheets in pitch. A cradle, constructed of a piece of 2-in. pipe, 2 ft long with a rod brazed to one side of it, was used to lift tap up the narrow lane between rows of steamer tubes. Extension on end of tap was started through a staybolt hole. Then it was grasped by a person outside of boiler, turned until guide threads were in handhole sheet and tap entered tube sheet.

By trial it was determined how far it was necessary to run tap into tube sheet to give full clean threads. Then all staybolt holes were tapped this amount. A fly cutter was devised which operated through each staybolt hole to give a machined surface on furnace side of tube sheet. This was done to make possible metal to metal contact of staybolt heads with tube sheet. Next the fly cutter was reversed and a machined surface cut around each staybolt hole on outside of handhole sheet to make metal to metal contact of handhole sheet and conical washer.

Staybolts were machined from staybolt stock purchased from boiler manufacturer with analysis and strain characteristics in accordance with code requirements. Tapered threads on staybolts were made slightly larger than tapered threads in tube sheet. Final fitting of staybolts was accomplished by tap and try method. When a staybolt was ready to install, a mixture of three parts of litharge and one part glycerine by weight was painted freely on tapered threads on staybolts. Staybolt was handed to man in furnace who placed it in cradle, moved it up through lane between rows of tubes and started square end through tube sheet.





No. 1 - Staybolt - O.H. Staybolt Steel.
No. 2 - Nut - Hex. Steel.
No. 3 - Washer - Steel.
No. 4 - Seal Washer - Copper.

Fig. 6—Detail of staybolt parts

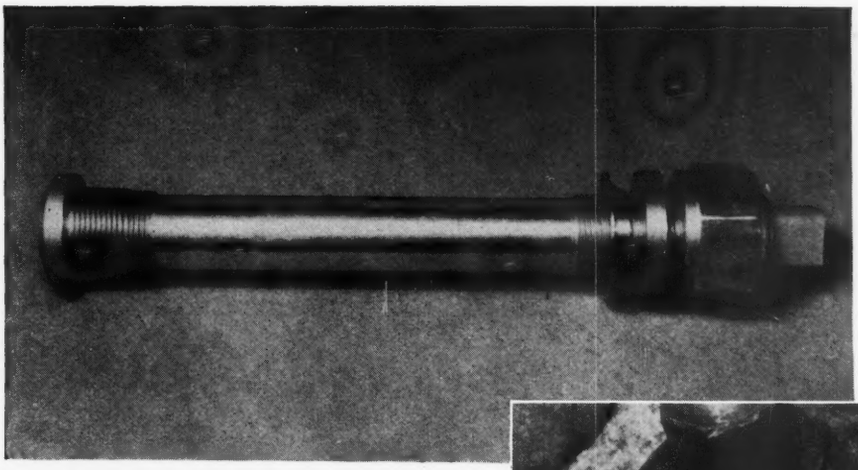


Fig. 4—A typical staybolt, new design

Fig. 7—Section of rear box-header, showing outer ends of new staybolts as installed

Men outside of boiler started it in threads by hand, then with a speed wrench ran it rapidly into place. A heavy socket wrench was then placed on the square end of staybolt and staybolt was tightened by two men with four foot bars, until head of staybolt contacted tube sheet. The threaded conical copper gasket was run on by hand until within ½ in. of handhole sheet. Then litharge and glycerine was painted on staybolt threads and machined surface of handhole sheet. Copper washer was quickly run down against handhole sheet, conical steel washer was placed against it and a nut made of 2½-in. hexagon steel was run on and tightened. Fresh litharge and glycerine was mixed for each staybolt.

The conical copper washer shown in Fig. 6 was machined on a 28-deg angle. A flat section was left at bottom of conical section. The steel washer, also shown in Fig. 6, was machined on a 30-deg angle and when placed over copper washer, could come within 1/16 in. of flat section of copper washer. When nut was forced against these two washers, first action was to force threads at outer edge of copper washer firmly into staybolt threads. Further pressure forced additional threads of copper washer solidly against staybolt threads, at same time forcing copper washer down against handhole sheet. Continued tightening of nut forced steel washer on down, stretching it slightly, until solid contact was reached.

Test Showed No Leaks

After the new staybolts were installed as described, the boiler was subjected to a 450-lb hydrostatic test, on Jan 21, 1938, and no leaks were found. The test revealed one additional cracked staybolt in front box-header which was overlooked at time of previous test. This staybolt was replaced with a new type staybolt. Fig. 7 shows a section of rear box-header after installation of new type staybolts. The left-hand threaded tip on staybolts shown in photograph was made to facilitate screwing staybolts into place. It was later found that these tips were unnecessary.

No. 4 boiler has been in operation more than a month since repair and inspections have revealed no leaks.

The different steps of designing tap, fly cutter, staybolt, and washers required considerable time and expense. However, now that the design has been perfected and proper tools and material are on hand, the time necessary for renewing staybolts can be reduced materially. If staybolts are made in advance, we estimate that two or three old staybolts could be removed and new type staybolts installed in eight hours by four men. About ten man-hours are required to make a staybolt complete with nut and washers.

A Small Plant Broadens Its

Broadmoor Hotel put in a 2700-sq-ft boiler and made use of local 11,090-Btu-per-lb coal.

Result: a typical month's record shows a reduction in steam costs of 7.06 cents per 1000 lb

FOLLOWING an improvement program adopted in 1935 (reported in POWER, October, 1935), Broadmoor Hotel, Inc, Colorado Springs, Colo., has installed a second new boiler. This unit replaces two obsolete ones, used for standby, on which pressure was reduced after the 1936 inspection.

This boiler is a fusion-welded, 3-drum, bent-tube unit with interdeck, 2-tube, U-loop superheater (one loop inside the other) in a single-pass setting. Drums, tubes and superheater elements are the same size as on the boiler put into service in 1935, but the new unit has only 2700 sq ft of heating surface as installed compared to 4044 for the older boiler. Capacity of the new boiler is sufficient to take care of load during the 9-month off season each year and to prevent crippling of service during peak months, in case of forced shutdown of the larger boiler.

Natural gas has been burned under the larger boiler since installation, with oil provided as emergency fuel. Now, however, coal can be obtained at attractive prices and under favorable conditions. 8350-Btu-per-lb lignite is available seven miles from our plant and semi-bituminous coal, averaging 11,090 Btu per lb, can be obtained from mines less than 50 miles away.

To insure against a natural-gas shortage in case of pipeline outage, and to eliminate, as far as possible, use of more expensive fuel oil, a tri-fuel burner was selected for the new boiler. This burner will handle pulverized coal, natural gas or fuel oil, but normally operates on pulverized coal.

Pulverizer

A pulverizer with a capacity of 3350 lb of coal per hr gives the boiler a steaming capacity of 26,000 lb per hr. Pulverizer capacity was based on an expected average demand of 16,000 lb of steam per hr, the average of three previous years. When the new boiler was ready for service, however, increased business had raised average load to about 19,000 lb per hr.

Furnace volume is 1680 cu ft, dimensions being 14 ft long, 8 ft wide and 15 ft from furnace floor to center of the lower row of tubes. As originally installed, the furnace was inclosed by refractory walls made up of 13.5-in. thick No. 1 firebrick backed up by 4.5 in. of heat-insulating brick, all inclosed in an electrically spot-welded steel casing. These refractory walls are independent of each other, having 1.25-in. expansion joints in each corner.

Furnace sidewalls are supported by two rows of bonding tile, full-wall width and anchored to horizontal buckstays. Front and rear walls are supported by a single row of bonding tile similarly anchored. This design was tested by four years of service with the larger boiler and did not require any maintenance.

Late in the spring of 1937, the new boiler was put into service with gas firing, and after control adjustments were completed, it was changed over to pulverized coal. Because of increased load, troublesome slag conditions soon developed, making necessary installation of waterwalls. These consist of 28 tubes in each side wall with external upper and lower headers, 16 tubes in the rear wall, and 12 tubes in the front wall. We can now burn any available coal without running into slagging problems. Flyash is so fine that most of it goes out the stack without leaving visible deposits around the

Principal New Power-Plant Equipment

BROADMOOR HOTEL, INC, COLORADO SPRINGS, COLO.

Boiler, superheaters, water walls, furnace, boiler settings, breechings and ducts	Babcock & Wilcox Co
Boiler heating surface 2700 sq ft; water walls, 1332 sq ft; rated max steaming capacity, 26,000 lb per hr; working pressure, 150 lb per sq in; total steam temperature, 470 F; furnace volume, 1680 cu. ft; max heat release, 22,000 Btu per cu ft per hr	
Furnace firebrick	Denver Fire Clay Co
Furnace-wall supporting tile	Babcock & Wilcox Co
Furnace heat-insulating brick	Babcock & Wilcox Co
Boiler heat insulation (Eagle Picher)	Joy & Cox, Inc
Coal pulverizer and feeder	Babcock & Wilcox Co
Combination coal, gas and oil burner	Babcock & Wilcox Co
Forced-draft fan	Clarage Fan Co
Combustion control	Bailey Meter Co
Coal- and ash-handling equipment	Stephens-Adamson Mfg Co
Water columns	Reliance Gauge Column Co
Safety valves	Manning, Maxwell & Moore, Inc
Non-return valves	Crane Co
Blowoff valves	Reading, Pratt & Cady Co
High pressure valves	Manning, Maxwell & Moore, Inc Edwards Valve & Mfg Co
Low-pressure valves	Crane Co
Piping	McCarthy Co, Inc
Pipe-heat insulation	Joy and Cox, Inc
Boiler-feed pump	American Marsh Pumps, Inc
Feed-pump governor	Fisher Governor Co
Feedwater regulator	Bailey Meter Co Atlas Valve Co
Feedwater treatment	Dearborn Chemical Co
Feedwater heater	Cochrane Corp
Flowmeters	Bailey Meter Co Brown Instrument Co
Steam-pressure gages	Babcock & Wilcox Co
Gas-pressure gages	Merriam Co Ellison Draft Gage Co
Draft gage	Ellison Draft Gage Co
CO_2 meter	Hays Corp
Thermometers, indicating	Manning, Maxwell & Moore, Inc Joy & Cox, Inc
Thermometers, recording	Manning, Maxwell & Moore, Inc
Turbine generator	General Electric Co
Condenser	Westinghouse Elect & Mfg Co
Circulating water pumps	Westinghouse Elect & Mfg Co
Hotwell pumps	Westinghouse Elect & Mfg Co
Air ejector	Westinghouse Elect & Mfg Co
Switchboard	Westinghouse Elect & Mfg Co
Voltage regulator	General Electric Co
Electric motors and controls	General Electric Co

Power Services

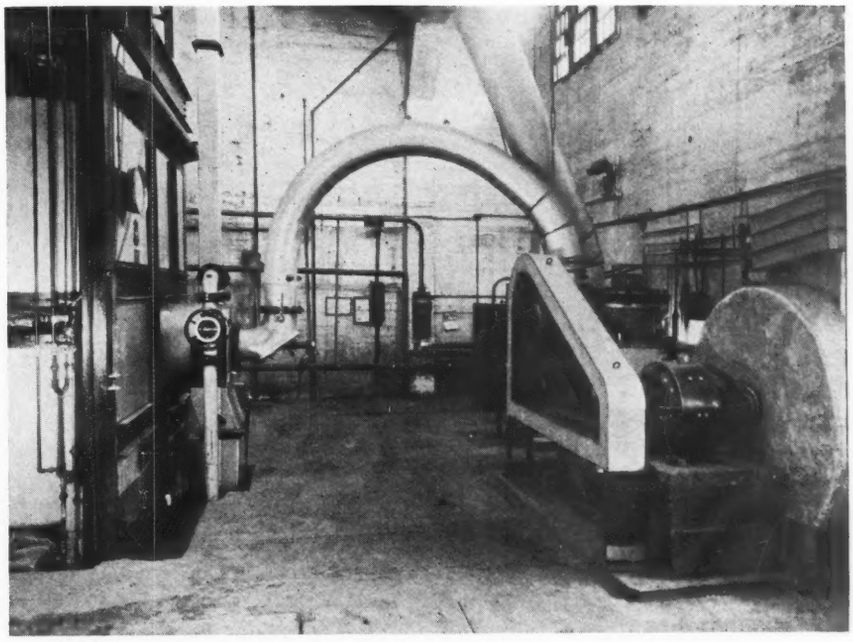
By J J MONAGHAN
Chief Engineer,
Broadmoor Hotel, Inc

plant; the rest is taken care of by hand cleaning the rear connection once a week.

Semi-bituminous coal is hauled by truck and dumped into an outside hopper, from where it is conveyed to an overhead inside bunker and flows by gravity to the pulverizer feeder. Ashes are handled by the coal conveyor and carried into an overhead bin, from where they are trucked away.

Operation of the new boiler has shown that steam is produced in our plant at lower cost with coal than with natural gas. For example, in March of last year, our steam costs were 7.06 cents less per 1000 lb than if we had burned natural gas.

Other recent improvements include a new 500-kw, extraction, condensing turbine with ac generator, a condenser and switchboard, purchased January, 1938. We have also completely replaced all dc equipment with ac, making our power equipment modern and up-to-date in all respects.



New boiler has combination burner that permits using either pulverized coal, natural gas or oil in this water-cooled furnace.

Exhaust Lines

When a crew of three huskies, with star drills and hammers, gave up after barely denting, in six hours work, a 7½-ft solid concrete wall in Pittsburgh's Liberty Automobile Tunnels, it looked as if the new 4-in. emergency pipe line wasn't going through. Then, under direction of M R Semmer, Air Reduction Sales Co, the needed hole was *burned* through in seven hours—a little over a foot an hour. Scrap metal placed in the partly-chipped hole was heated to 2500 F with an oxygen lance. Heat disintegrated the concrete around the metal and by continuing feeding of steel scrap and application of lance, the hole was made deeper and deeper. Molten metal, flowing out under pressure of oxygen lance, carried away pieces of concrete.

The "old-fashioned way" is on the skids apparently, with electricity replacing the old reliable beefsteak as a black-eye cure. For the benefit of the scientifically minded, and the guy who came out second best, the process depends on the idea that bruised tissue (black eye to you) gets cured by the action of a fluid called histamine. This can be made synthetically, and here's where electricity comes into the picture. Histamine soaked cotton is applied to the enpurpled glim and connected with the positive pole of a battery, the other pole being connected to the body. Current flow makes the histamine get on the job, forcing out the blood pigment. Result: no more black eye.

Two men, never one alone, inspect heating tunnels connecting official buildings in Washington. Temperatures reach 160 F in hot spots and collapse might be serious for a man alone, since tunnel traffic is light. Another hazard is presented by vagrants who learn to whittle keys to fit manhole-cover latches and set up light housekeeping in the warm tunnels. Two inspectors, average weight 200 lb, meet with fewer arguments.

The consultant comes in for some good-natured ribbing in "Business for Pleasure" by Mark Spade, British economist. His definition: "It is not easy to give a precise definition of a consultant. He is, of course, an Expert. But then there are thousands of experts who are ordinary honest men working in the usual way. Again, he is not a permanent employee. He only comes in to do a certain job and goes away again quickly before anyone can see the snag. But so does a plumber. And manifestly a plumber is not a consultant. At least not the sort I mean. Moreover an ordinary Expert or ordinary Plumber has to produce some credentials to show that he is an expert or a plumber. But it is an essential feature of the true consultant that you don't ask rude questions . . . you just take him in a spirit of sublime trust. In the last analysis, I think the only way of deciding whether a man is a consultant is to look at the amount he is paid."

A thermoplastic cellulose-acetate product 0.001-in. thick can be applied to both sides of blueprints, documents, and will protect against wear, mold, or insect attack. Got any termites?

Multiple-Retort Underfeed Stokers

Fifth of a series of articles on modern stokers points the way to intelligent firing-equipment selection by blueprinting multiple-retort underfeed units

By L N ROWLEY
Assistant Editor

BASIC principles of operation are the same on nearly all multiple-retort stokers. Plungers feed coal to a series of trough-shaped retorts; the green fuel moves upward through the front end of the fuel bed, mixing with air supplied through rows of tuyeres dividing the retorts. Coking occurs as the fuel passes upward; the volatiles distill off and burn, and the coke itself burns as it reaches the top of the fire. During this process, the entire fuel bed is moving slowly to the rear of the furnace.

Nearly all units have an overfeed section or extension grate on which combustion is completed. Ash discharges from the end of the grate surface. Reference to the stoker sections shown on the opposite page will give a general idea of the mechanism for carrying out this combustion cycle. For a more complete understanding of the means by which various designers have achieved the desired action, let's consider each stoker element separately, comparing designs.

Feeding rams—Ram boxes and rams may be horizontal or inclined at the angle of the grate surface; most rams are cylindrical, but at least one manufacturer uses a square plunger. Plunger stroke is also adjustable on this stoker. In most units, construction of ram box and plunger is such that wearing parts may be readily renewed; the tip of the ram-box cap is usually made as a separate casting to facilitate replacement.

Retorts and secondary coal feed—Diversity of approach by designers becomes evident when means of producing and controlling the movement of the fuel bed are examined. Roughly the problem is this: to move the fuel bed at the proper rate from front of stoker to rear, to maintain continuous agitation to break up the lumps formed by the caking coals usually burned on underfeed stokers, to provide for changing the rate of feeding and moving at different spots in the fire bed, and to correct thick or thin spots which might develop. A common solution depends on secondary rams or pushers in the retorts, driven from the main ram or directly from the stoker gear box. The stroke of the pushers may be adjusted individually or in groups, to control local fuel-bed conditions.

A variation of this arrangement features sliding retort bottoms, with auxiliary pushers mounted on them; adjusting motion of sliding bottom controls fuel distribution. A different method is employed in a stoker in which the sides of the retorts (made up of tuyere blocks) reciprocate. Tuyere blocks, overfeed grate sections and rocker dump plates are all assembled on sidebars, two to a retort. These sidebars are connected by linkage to the main plungers and move with them. Reciprocation of the grate surfaces provides the motion and agitation required, and changing the travel of the sidebars gives control over fuel-bed conditions.

Tuyeres—Most units employ flat tuyere blocks grooved or vaned to produce a number of small air streams to insure good distribution. To keep metal temperature down, thus prolonging tuyere life, tuyere blocks on one unit have extended surface, while another design depends on reduced tuyere height which gives a greater number of tuyere blocks per foot of stoker length and increases the air-swept surface. One stoker has tuyere blocks laid vertically, with air moving up and out sides and top. Most units have high sidewall tuyere blocks for protection. The air stream at the side tends to prevent clinker adhesion.

Extension grates — When fuel reaches the lower end of the stoker, only coke and ash remain; to burn this coke efficiently and thoroughly, uniform distribution of air at lower pressure is required. This is accomplished by extension or overfeed grates. In most cases, these grates reciprocate, driven from the pushers. Moving and stationary surface is variously disposed, and, as can be seen from the cross sections, the surface may be either flat or stepped.

As previously described, the extension grate sections in one stoker are driven from moving sidebars, there being one grate section for each sidebar. Thus all extension grate surface moves, but adjacent sections move in opposite directions. In another unit, the extension grate is made up of link-grate sections, which move in a wave-like manner, feeding fuel and ash to the stoker end and providing continuous agitation.

Ash disposal—Basically there are two methods of ash disposal—by dumping, and by continuous discharge to a clinker grinder. The method used depends on ash content of coal, rate of operation, and size of stoker. Roughly speaking, where large quantities of ash must be handled, continuous discharge and grinding is justified; dumping will be adequate in all other cases except where grinding is necessary to prepare ash for disposal. On all but the smallest sizes, dumping grates are power operated, a steam cylinder being the usual actuating medium. Quick dumping action prevents excessive infiltration of air from the ash pit. One unit has a dumping mechanism arranged so that the dumping grate may be lifted slightly above its normal position, breaking off clinkers on the bridgewall.

Some of the advantages of continuous ash discharge with grinding are claimed for two devices having something of the simplicity of dumping grates. In the first, a rocker dumping plate is used, hinged at one end (see illustration) and supported by a linkage. The hinged end moves with the extension grate and tuyere blocks, driven from reciprocating sidebars. This action breaks up the ash and a part of the refuse is continuously disposed of, making clean-

ing periods infrequent. Stokers with link-grate sections are arranged to dispose of ash continuously, the wave-like action of the grates pushing the broken ash down on a flat discharge plate under the bridgewall, and into the ash pit.

Use of crusher or clinker grinder rolls increases stoker length and a deep ash pit is required to permit combustible to be burned out completely. On the other hand, grinding helps reduce carbon loss, improves furnace conditions, and is necessary where large quantities of ash are to be handled. Usually the front wall of the ash pit is ventilated for cooling and to help burn out combustible. Waterwalls (usually with protective armor) at the back of the pit assist in cooling the ash and so reduce maintenance. Where double rolls are used, they rotate outward, against adjustable breaker plates. To facilitate maintenance, rolls are usually built with renewable teeth.

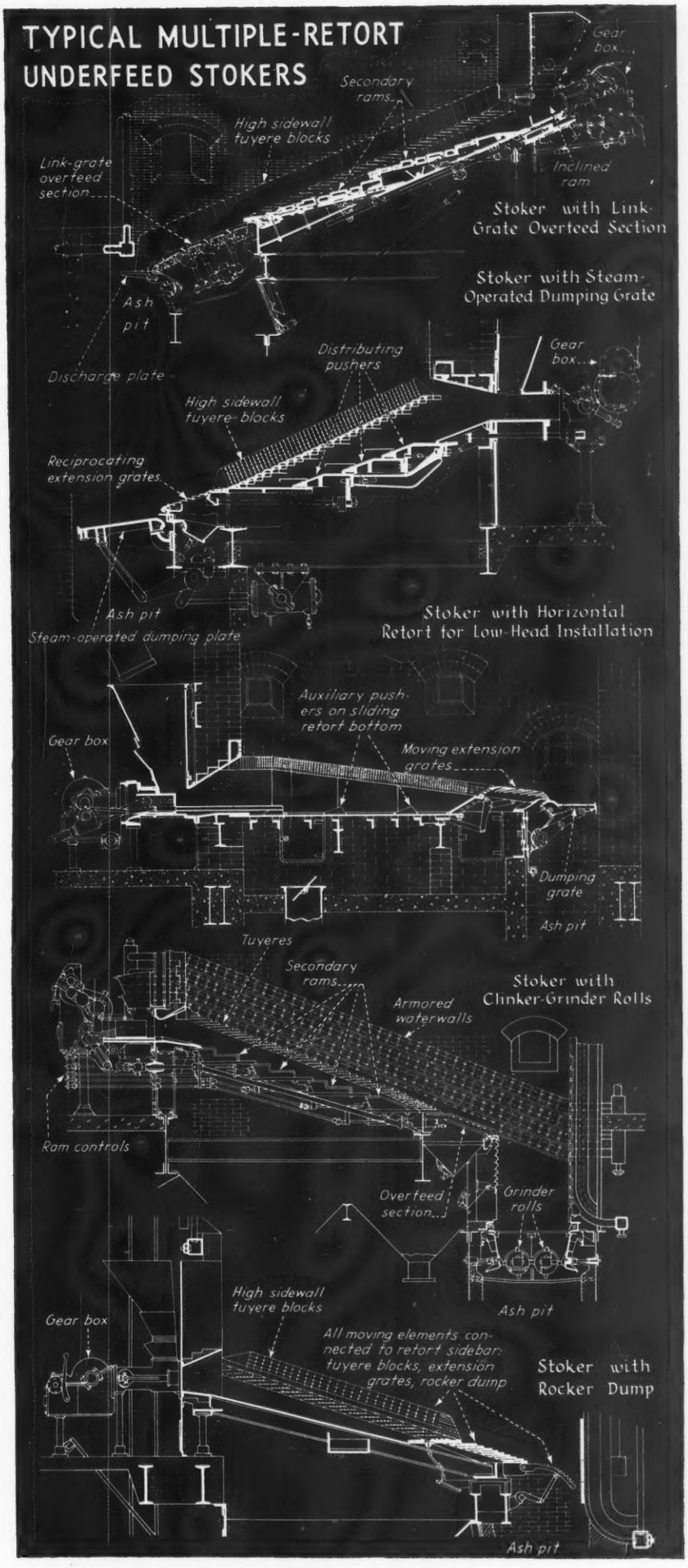
Air distribution — Air passing through a stoker fuel bed has a triple job to do; it carries oxygen for burning the fuel, and in sweeping through the fuel bed it scours away inert products of combustion, thus exposing new carbon surfaces to oxygen, and finally, air cools stoker parts, protecting them from excessive heat. Good stoker performance requires the right amounts of air, properly distributed.

In the average multiple-retort unit, air, from a single fan or common duct supplying several stokers, enters a large windbox under the main grate surface, flow being controlled by a damper at the inlet. The overfeed or extension grate section, and in some cases the last rows of tuyeres, are usually partitioned off and air supply to these sections is under control of a separate damper. Air to the dump plate and ash pit may be regulated by the same damper as the extension grate or by separate damper.

As fuel beds get larger, this system of air control may not be entirely adequate, or certain fuels may require better air control. The solution is to divide the fuel bed area into smaller units each with individual control damper, so-called "zoned air control". Operation of the unit dampers may be manual or automatic.

Fans for multiple-retort stokers are always separate units, more or less removed from the boiler, and so constitute a distinct problem, not within the scope of this article.

Gear boxes—In usual practice, coal-feeding rams operate from crankshafts driven from some power source through a gear box. One such gear



box may drive three or more rams; wide stokers may have two or more gear boxes, permitting changing the coal-feeding rate over part of the width. The usual arrangement features two speeds and neutral. Mechanism may be a spur-gear planetary drive, without clutch, or may use clutches in combination with either a spur gear train or a worm-and-wheel train. In one unit, speed change is dispensed with, only speed reduction being included. In another, rams can be hydraulically operated, with fluid supplied by a Hele-Shaw pump. This combination has a speed range of about 25-1.

Stoker drives—Choice of drive for stoker will depend on load conditions which fix maximum and minimum operating rates and number and rapidity of load changes, and also on the expenditure that seems economically justified for flexibility of control. Where only a narrow speed range is required, with few intermediate speed points, electric motors are commonly used. Adding a variable-speed transmission between motor and stoker gives a wider range and almost infinite intermediate positions. Steam engines and steam turbines also give flexible control and may be preferred because of heat balance. One stoker is equipped with an integral turbine drive; a throttle-controlled turbine drives the gear-box speed shaft through helical gearing and a silent chain, the entire unit being self-contained.

Two general types of hydraulic drive can be used. In one, the stoker is driven by a variable-speed oil motor supplied from a variable-displacement oil pump driven by a constant-speed motor. In the other, oil from the pump acts directly on hydraulic rams for coal feeding. Either arrangement gives a wide range of speed with any desired intermediate speeds.

Control—Again depending on load conditions and outlay justified, a wide variety of control arrangements for multiple-retort stokers may be considered. Simplest and cheapest is manual control of coal feeding and damper operation. In many cases, however, some measure of mechanical control is justified, and this usually includes stoker-speed control, outlet-damper control, and control of entering air by either fan speed, vanes, or dampers.

Fuels—Best results come with bituminous coal of medium caking qualities, low ash, low moisture, and in sizes from 2½ in. down, with ¾-in. nut and slack usually used. Ash-fusion temperature requirements must be determined for the individual plant since furnace design and operating conditions are important factors. With proper allowances, a wide range of fuels can be burned on underfeed stokers. This range is likely to be extended considerably by the still fairly recent development of water-cooled stokers.

Water-cooled stokers — Actually this term is employed to describe a completely water-cooled furnace, stoker-fired. The general scheme involves cooling tubes running under retorts and along tuyeres, which tubes are tied-in to the boiler water system. Circulation may be forced or natural. This added water cooling increases radiant-heat absorption, lowers temperatures in the fuel bed, and tends to chill ash, preventing the closing of air ports, reducing maintenance. Such stokers are now being operated on low-grade coal, high in moisture and ash, and with low fusing temperature.

Installation—It is not practical to consider in detail the installation of multiple-retort underfeed stokers. Average heat release in stoker-fired furnaces is around 35,000 Btu per cu ft per hr, but ranges from 25,000 to 65,000 depending on fuel and firing rates. The usual cautions about allowing sufficient height between grates and boiler surface apply.

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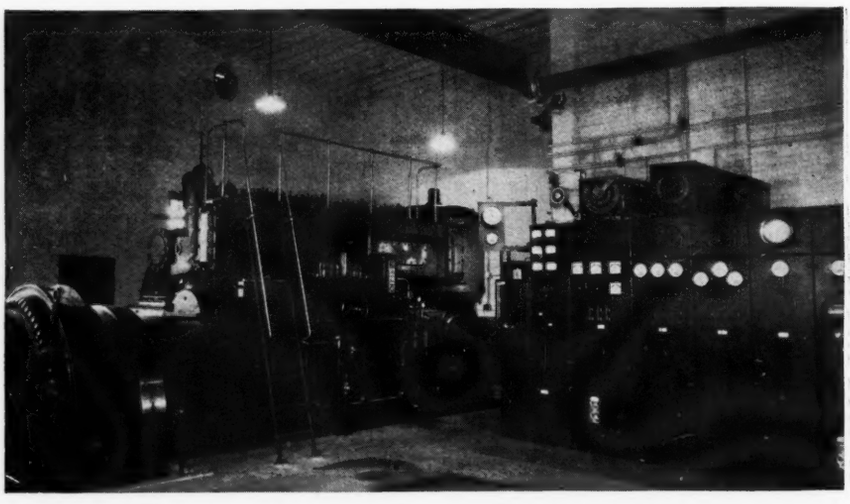
Municipal Combines Diesel and Steam

By ED SWAN

AN INTERESTING example of the tendency to combine steam and diesel power to meet certain load conditions is the Holdrege, Neb., municipal plant, where a 750-hp diesel-engine generator was recently added.

When consideration was given to a new unit, the plant consisted of a 600-kw G E turbine supplied with 250-lb steam by a 3150-sq ft Murray boiler, natural-gas fired, and two Murray steam engines (150 kw and 200 kw) supplied with 150-lb steam from 3 hrt boilers, also Murray. Operators depended on the turbine almost entirely since the engines were uneconomical and not always able to carry the peak. Turbine operating periods were excessively long, without opportunity for needed maintenance.

After careful consideration, the management and the City Council decided that a diesel was the solution. It was reasoned that the turbine and its steam generating unit could be shut down at any time and the diesel, with help from the engines, would be able to handle the load. Experience has shown that the diesel alone can meet most loads, and standby losses on the battery of 150-lb boilers have been virtually eliminated.



The engine installed is a 2-cycle, 5-cyl, 16x20-in. 257-rpm Fairbanks-Morse diesel, equipped with Woodward governor, direct-connected to a 517-kw, 2400-volt generator. Main lubricating-oil circuit covers main bearings and wristpins, and oil is used to cool pistons, flowing from the inside crown through telescoping tubes to the crankcase. When the engine is running, a direct-connected oil pump lifts oil to the cooler and strainer and back to the engine. When the engine is not running, an auxiliary pump circulates oil.

What's Next in Diesel Fuels?

Modern refining methods bring new oils and new problems for the operator—this article tells what's happening and what to do about it

By JOHN M DRABELLE
Mechanical and Electrical Engineer
Iowa Electric Light and Power Co

DIESEL ENGINE operators today have a wide range of fuel oils to choose from, a range so wide that choice on a basis of fact rather than personal whim or opinion is exceedingly difficult. Furthermore, oil classifications are changing, due to new methods of refining and to the efforts of technical societies to standardize fuel-oil classifications. This article attempts to survey the changes taking place and to give some pointers on selecting fuel oils.

Years ago, diesel fuel oil was almost in the byproduct class with little or no market until use of internal-combustion engines became widespread and the automatic domestic oil burner came into its own. Essentially a gas-oil product, price of fuel oil was determined by the old law of supply and demand and, since demand was small, price was low.

Advances in Refining

Amazing technical progress, concentrated on the production of high-octane anti-knock gasoline, changed this situation. The old refinery, chemically speaking, was rather simple—it has been replaced by today's cracking process in which high-pressure, high-temperature stills permit a greater percentage of crude to be turned into gasoline. Products which formerly resisted the efforts of the refiner to convert them into gasoline and were sold for water-gas manufacture, diesel and industrial furnace fuels, are today put through complex processes and turned into gasoline. Polymerizing has come into the picture recently, affecting the position of refinery gas, butane, and propane, and today there is comparatively little straight-run oil on the market. Fuel oils of the future will be cracked and not straight-run products, and diesel users and designers must look this situation squarely in the face.

Modern refinery processes can be adapted to producing a large variety of fuel oils, but only at a somewhat higher cost to the user. There is a definite tendency on the part of the petroleum industry to reduce the number of classifications of fuel oil, and looking into the future we can see four probable fuel-oil groups, as outlined in Table I. Table II sets forth results of consideration of this problem by a special committee of the American Society for Testing Materials, working in cooperation with the American Petroleum Institute. The ASTM has also considered the fuel requirements of diesel engines running at different speeds and makes the recommendations given at the end of Table II.

Indiscriminate purchasing of fuel oils cannot be justified, due to basic variations in characteristics. As an example, due consideration must be given to cold-test results. Care in this respect will insure blending when oils are unloaded into storage tanks, and prevent stratification as outdoor temperatures go down.

Engine characteristics determine to a large extent the fuel-oil specifications in any given case. For the so-called semi-diesel a high-grade oil will give superior performance. Experience seems to indicate that this class of engines must have such a fuel, and there is another group of two-cycle solid-injection crankcase-scavenged engines that are also somewhat critical as to fuel. 2- and 4-cycle air injection engines have the ability to burn oil of rather poor characteristics. The solid-injection, 4-cycle engine, while not as touchy as its 2-cycle counterpart, cannot handle oils of the same character as those often burned in air-injection units.

As the fuel-oil situation becomes more critical and it becomes more dif-

ficult to obtain premium oils to meet characteristics of individual engines, manufacturers and designers of existing engines may be forced to provide such engines with new injection gear, pumps, nozzles, and perhaps a change in cylinder heads, to permit using lower grades of fuel. Users and builders will need to know more than ever about the characteristics of fuel oils and how these characteristics affect performance in the plant.

Valuable work in determining the igniting qualities of fuels has been done by Dr R T Goodwin and T B Rendel of the Shell Petroleum Corp. By comparing different oils with cetane in a CFR engine, an equivalent cetane number is obtained which is an index of the igniting quality of the fuel. In one way, there is nothing new about the cetane number, but its peculiar technical characteristics were not defined in a detailed manner until the work done by Goodwin and Rendel. Thus the diesel operator often referred to an oil as good or bad, judging by the peculiar sound of the engine while burning the oil. The engine and the ear of the operator were a crude form of knock meter, and when the operator said, "Listen to that oil", he meant just that.

Cetane Number

Cetane number of fuel oil may be likened to octane number for gasoline. Briefly stated, it is a yardstick for measuring ignition quality of diesel fuels. On this scale, cetane is selected as 100 and alpha methyl-naphthalene as zero. The cetane number of a given fuel is the percentage of cetane mixed with alpha-methyl-naphthalene that matches the ignition quality of the tested fuel. For example, if a fuel oil has the same ignition quality as a mixture of 60% cetane and 40% alpha methyl-naphthalene, the fuel has a cetane number of 60.

There are two ways to determine cetane number. In both, a single-cylinder diesel engine with a mechanism for varying compression ratio while other operating conditions are held standard, is used. In one case the critical compression ratio is found, in the other ignition delay is measured. A complete discussion of methods will be found in a recent publication of the Texas Company, "Diesel Engine Operation—Fuel and Lubricants". Another source of information is a paper by T B Rendel, Director of Engine Research Laboratory, Shell Petroleum Corp, entitled "The Reasoning behind Diesel Fuel Specifications".

Laboratory work done by the writer's company, checked against monthly operating results of a large number of diesel power stations, indicates that engineers should give serious consideration to the work of Goodwin and Rendel. For example, it has been found over a period of years that specific gravity means practically nothing as an index of the value of a fuel oil in a power station.

On the other hand, pour point must be given careful consideration. Knowing climate and temperature conditions at a station determines many things in connection with the unloading, storage, and handling of fuel oil. A station in a warm climate can operate with an oil of higher pour point than a station located in a cold climate. However, when summer comes, the Purchasing Department shouldn't be handicapped with a request for low-pour-point oil when a high-pour-point oil would be just as good under summer conditions.

Viscosity, as measured in the Saybolt Universal apparatus, tells much about the probable performance of oil in the engine injection system. High viscosity may require heating coils in the day tank to insure delivery of a fluid to the fuel pumps and injection system, but the temperature must not be too high or flashing and vapor binding in the pumping system may result.

Viscosity has, likewise, a bearing on the performance of fuel-injection pumps, and a fuel of low viscosity tends to increase leakage between plungers and produces a reduction in injection pressure. It is also true that fuel oils of low viscosity have little if

TABLE I PROBABLE FUTURE FUEL-OIL CLASSIFICATION

Probable Number	*Present Number*	*Remarks*
1	1	Distillate 38–40
	2	Probably out
3	3	New No. 3 will have gravity and cold test characteristics of old Nos. 2 & 4 combined
	4	Old No. 4 probably out
5	5	New No. 5 will combine characteristics of old Nos. 4 & 5
6	6	All heavy oil

TABLE II ASTM DIESEL FUEL-OIL CLASSIFICATION (ABBREVIATED)

	Grade of Fuel				
Characteristics	1-*D*	3-*D*	4-*D*	5-*D*	6-*D*
Saybolt University Viscosity:					
at 100 F minimum	35	35	.....	.....	.....
at 100 F maximum	50	70	250	.....	.....
Saybolt Furol Viscosity:					
at 122 F maximum	.....	.....	.....	100	300
Pour Point, F maximum	35	35	35	.....	.....
Cetane Number	45	40	30	.....	.....
Diesel Index	45	30	20	.....	.....
Flash Point, F minimum	115	150	150	150	150
Carbon Residue, % by vol, max	0.2	0.5	3.0	6.0	.....
Ash, % by weight, maximum	0.02	0.02	0.04	0.08	.....
Sulphur, % by weight, maximum	1.5	1.5	2.0	2.0	2.0
Water and Sediment, % by vol	0.05	0.1	0.6	1.0	.....

ASTM DIESEL FUEL RECOMMENDATIONS

Grade	*Type of Engine*
1-D	Solid-injection engines operating at more than 1000 rpm
3-D	Solid-injection engines operating from 360–1000 rpm
4-D	Solid-injection engines with cylinders more than 16-in. in diameter, and operating at less than 240 rpm
	Air-injection engines operating at less than 400 rpm
5-D	Air-injection engines operating at less than 240 rpm
6-D	Used only in isolated instances

any lubricating properties and increased wear on fuel-pump plungers is noted under such operating conditions.

Formation of carbon on the fire side of the fuel-injection nozzle is a critical consideration in some engines, particularly two-cycle solid-injection units. This brings into the picture the Conradson Carbon Number. In our experience, high Conradson does not necessarily mean piston ring trouble, but does foretell probable poor injection-nozzle performance on certain engines.

A point often overlooked by the operator and, incidentally, not given sufficient consideration by consultants and diesel manufacturers, is the fuel-oil strainer. Every possible care should be taken to keep the fuel-oil unloading hose and its connections absolutely clean and free from dirt. This dirt gradually accumulates in storage tanks and later may come over into the day tank through the fuel transfer. Large and adequate strainers are essential to catch this type of dirt. A strainer of still finer mesh at the fuel inlet at the engine gives needed back-up protection, keeping fine grit from entering close clearance crevices and so saving wear and tear. A good rule to follow is to buy a clean oil from a reputable refinery and then make every possible effort to keep that oil clean from tank car to fuel-injection pump.

These thoughts on fuel oil are based on 14 years of experience operating diesel stations with many kinds of fuel oil, years of close cooperation with laboratory and purchasing department to obtain the best possible fuel at reasonable cost. Times and conditions change, and we must adapt ourselves to the new conditions in the fuel oil situation as it exists today.

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Stack Down, Steam Blows Up, Plant Keeps Going

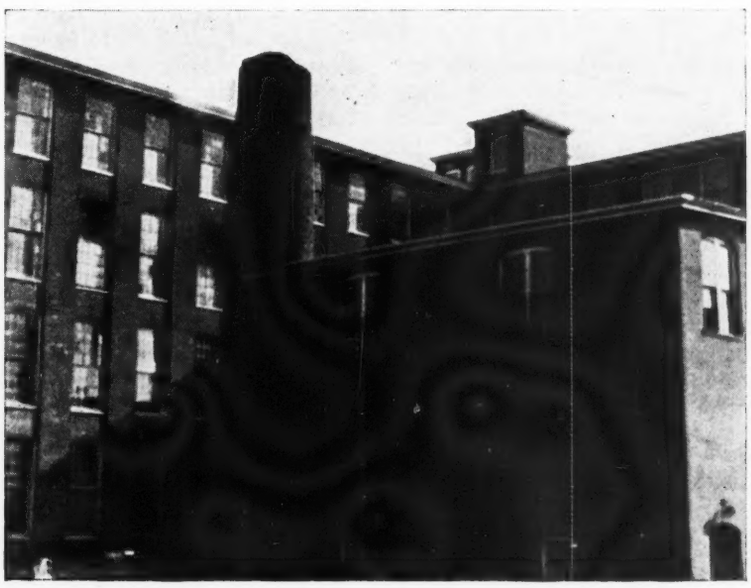
By PETER F KEOUGH
Plant Engineer, Sagamore Mfg Co

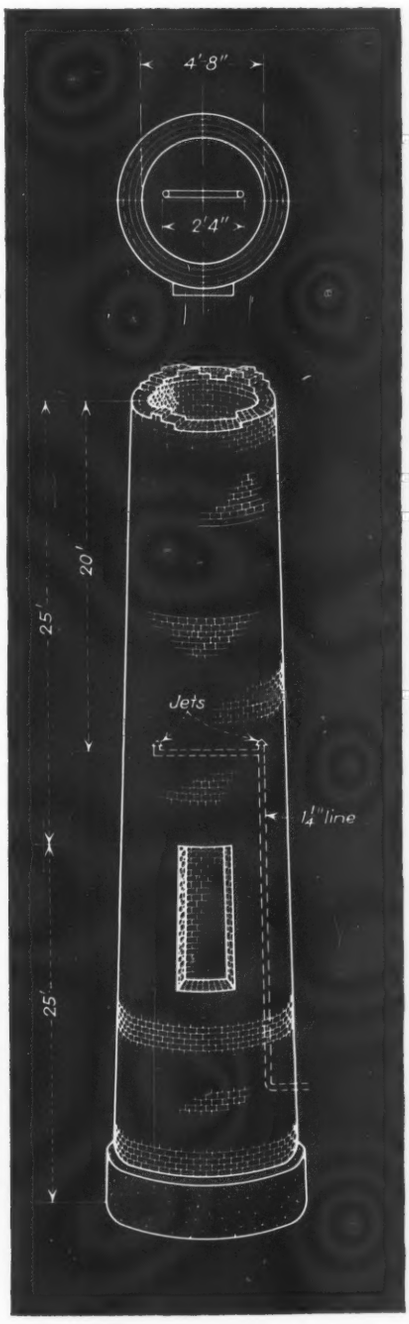
DURING the hurricane that swept the southern part of New England on September 21, 1938, 115 ft of a 165 ft stack on our No. 1 mill was blown down. With the mill running 24 hours a day and with orders promised on a penalty basis, it was up to the Engineering Dept to cope with the situation quickly and efficiently.

Boilers served by the stack are hrt with Green economizers between main flue and stack. Normal rating of each of the six is 1500 sq ft, and 30% overload must be carried to keep all departments of the mill in operation.

After making a careful study of steam velocity and steam expansion and temperature, it was decided to put in the stack two syphoning steam jets which had been used for blowing tubes in Nos. 1 and 3 mills. As there was an economizer plus fuel-bed resistance to be overcome, the jets had to be placed at the proper height to assure velocity at the exit and prevent any blanketing effect. If jets had been placed too high there wouldn't have been travel enough for re-expansion of the steam to fill the stack area (56 in. diameter at point of break), and there would have been eddy currents of air pulled down from the top of the stack to the syphons. The photo shows the condition of the stack, and the drawing illustrates the location of the ½-in. orifices fed by a 1¼-in. pipe, carrying full boiler pressure (155 lb).

On the following Monday, Sept. 26, at 7:00 a.m., the mill was started and full load has been carried on these boilers without interruption for 24 hrs a day ever since. No difficulty has been experienced in coping with the situation, nor has it been necessary to add to boiler-room personnel to meet steam demands.





PUBLIC RELATIONS for POWER MEN

The Human Side

Many POWER readers will remember Dan Gutleben's "Log", wherein he records new ideas, happenings around the plant—everything in fact. When we asked for his idea of public relations in the power plant, he went through the Log and took out paragraphs here and there. Put together, they reveal better than anything else that warm human understanding and a spirit of comradeship will create more cooperation and enthusiasm than any number of charts and formulas

IT HAS ALWAYS been good sense for a boss to be decent to his men. And recently it has also become legal! A faithful old laborer, without analytical mind, had operated a certain 8-in. screwed-stem gate valve thousands of times. This valve passed the centrifuged raw sugar as it was sluiced from the washed-sugar trough to the melters. The debris that is "occluded" with the slurry sometimes lodged in the valve and, before it could be cleared by the slow closing and opening of the gate, the pipe plugged and caused a flood.

It dawned upon the operator that with a quick-opening valve, a jerk of the lever would flush out the debris. He got up his courage to make a humble suggestion to Bigga-da-Boss, then new on the job. Five minutes later, six pipe fitters proceeded with the work and proved a good idea (the six was for dramatic effect!)

For the next few weeks, the boss was deluged with suggestions and never thereafter was there any fear of approaching him with ideas. Some ideas are raw and impracticable, and on occasion the Boss is hard put to find language of sufficient perspicuity to satisfy the man that his idea got an unprejudiced hearing but wasn't practicable.

Producing Suggestions

The operator's propensity for producing suggestions should not be allowed to wither. On the other hand, when God made the faithful Polander, the job was permanently finished. He does not possess the plasticity of cast iron and so, to keep him happy, a machine sometimes has to be changed. Incidentally, recording instruments have to be installed as a guard against operating forgetfulness.

The "Log" records anecdotes of the behavior of men as well as machines. Wizzard Dost devises a particularly ingenious electrical gadget and a description and drawing appears in this book. A headline of a New Jersey village paper announces that the tax rate has been decreased by $0.75 due to the special efforts of construction foreman Eckstein who is the village assessor and watch-dog. A politician had tried to stampede the citizens into purchasing a school site for $27,000. Eckstein found a more suitably located piece for $6,000.

Captain Tom makes arrangements to cut Sunday and take his wife to Atlantic City. He actually does, but the old force of habit still prevails. On his way to the Delaware Bridge, he stops at the boiler house, visits his favorite toilet, takes a glance at the control board, and then beats it to the shore with a clear conscience.

All of these matters are recorded in the Log along with mechanical statistics and extra-curricular activities of more or less humorous nature. The Log is profusely illustrated with sketches and photographs. The "Old Man" has a copy on his desk. In his trips through the House he accosts the "perpetrators", bums a chew from the family plug and proceeds with a bit of pleasant conversation. The boys know that their deeds are recorded and they talk about it.

Boiler-House Drama

A few weeks ago the boiler house stack was emitting a cloud of black smoke. Warning was sent to the fireman to be careful! Shortly after, a message was received requesting the Engineer to call the Principal of the Chandler School a couple of blocks away. The smoke had not yet gotten under control. However, all the principal wanted was an invitation to take her "opportunity class" (euphemism for rascality) through the refinery. Could she come in? You bet she could!

It required one police sergeant, two teachers and three refinery attaches to keep the dozen kids on the right track. When they finally reached the end of the trip, they had their pockets bulging with sugar samples and they yelled an enthusiastic vote of thanks. Smoke or no, some good-will was engendered.

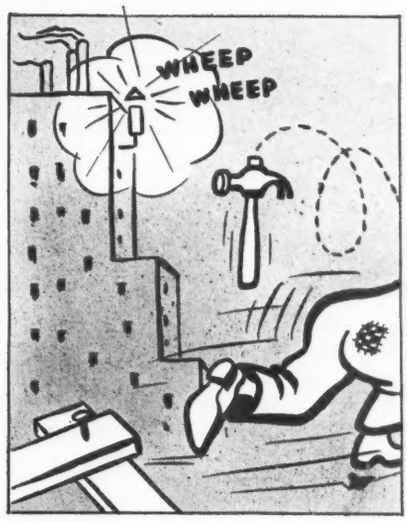
Sandlot Politics

A neighborhood sandlot ball orchard was acquired for the erection of molasses storage tanks. During construction of the foundations, the kids voiced their feelings by heaving brickbats at the workmen. The Engineer happened along with a transit. The kids' curiosity got the better of their timidity, and one of them edged up close and accepted an invitation to have a look through the telescope. The ludicrous antics of a drunk a quarter of a mile away caused him to let out a yell and brought the pack to the transit. In a little while the kids hollered, "Sure, you can't help it, we gotta have work for the unemployed."

During the flush of the post-war period, when raw-sugar producers made returns above 50%, the great Cuban gambling proclivity flourished. A few centavos or pesos, or pieces of American silver, sometimes got lost in a stack of sugar and weren't worth the search. Our company paid the duty at $1.90 per 100 lb plus the freight and got no sugar out of this foreign matter, but it provided the stimulant that made the onerous smelter job attractive.

Salting the sugar pile

Dutchman discipline



Hammer hanging in air

Later, when housewives learned that sugar was to be had freely at the corner grocery, they quit buying more than they needed and so the bubble burst. Gambling on the Cuban sugar pile immediately became depressed and, sympathetically, interest in the week-end job at the refinery at Philadelphia sagged. However, foreman Bill Booth knew his Polander and he didn't disparage the profit motive. So he salted a silver dollar in the melter and saw to it that on this particular week-end at least, the job was thoroughly done. The effect lasted six months and the salting was then repeated. It cost Bill $2 a year to save some hours of personal supervision but the results were pleasant and profitable.

One on the Boss

On a Western beet-house job, the "Old Man" once handed us the chore of building a 1500-ton wooden barge. For a crew of maintenance men, this was a little out of the ordinary, and when the craft was ready to be launched, there was some excitement. The boss, having designed the structure, had a desire to be present and kick off the key. The carpenter announced that tide would be high at 4 a.m. When the boss arrived next morning at 4, the barge was floating comfortably in the water. The carpenter and a few helpers had beat him to it. The boys occasionally like to put something over on the boss and then watch his expression!

The country villages, where the beet houses are, usually have a few colored citizens that have to be taken care of. These men are assigned to the lime kiln house where colors can blend harmoniously. In Caro, Mich., in 1900, old Doc Portius was superintendent. A Prussian superintendent in those days was also King. He came unexpectedly upon a 15-cent-per-hr operator and found him resting! Unconceivable! He demanded to know "Vat you make?" The colored fellow, white with fear and lime dust, knowing that he was to be fired, answered "21 cents an hour". Whereupon the Doc in great wrath ordered the time office to reduce this operator's rate to 17½ cents!

Proof of the Pudding

A maintenance carpenter who received 70 cents per hour once told the boss that he had a chance to get a job with a carpenter crew outside at $1.25 per hour and requested advice. The boss told him that the best way to find out was to try it and if it didn't work out, to come back. In a month, the man returned to his old job and is now a valuable and faithful foreman.

In a sugar house, the precise boundaries of authority cannot always be adhered to conveniently. When there is an interruption in plant operation, everybody has to dig in to get things going. The superintendent is Moses and Engineer Aaron stands by to hold up his right arm. Cooperation among the leaders plus enthusiasm become contageous and soon affect the rank and file.

From King to Comrade

The boss used to be king and could command the servant to go thou and do thus. But now he is a comrade and his orders are sometimes modified by rule of the committee. To keep the job moving with the old vigor now requires the boss to possess diplomacy. The paternalistic weapon is gone. However, our gang has not yet reached the stage where the hammer is left hanging in the air when the whistle blasts.

Occasionally on a Sunday p.m., the boss circulates around with his camera at the homes of the boys and gets acquainted with the kids and the wives. It is almost pathetic to observe the pleasure that can be inspired by a little fraternizing. On Christmas, Master Mechanic John's little granddaughter asks granddady why he isn't going to the sugar house "where he belongs." Herman's little orphaned grandson gets sleepy and informs granddaddy that he is growing blind and so Herman has to tuck him in bed.

Christmas Spirit

On Christmas morning two years ago, the boss dropped in at the plant and was informed that Rolly, the shift foreman in the steam plant, had slipped on the ice and had been sent to St. Mary's. So the boss drove over to the hospital (the policeman overlooked his passing a red light) and found Rolly on his back, but in good spirits. He told the youngster that Daddy wouldn't be able to come home. The little fellow wouldn't believe it, as he said his daddy had told him he'd be home on Christmas.

"He may have a greasy hat, and the seat of his trousers may be shiny, and the banker may not be very well acquainted with his signature, but if you see his children with their noses flattened against the window pane watching for him a half-hour before he is due home for supper, you can go right ahead and trust him with anything you have."

A MAN *without mirth is like a wagon without springs, in which one is caused disagreeably to jolt by every pebble over which it runs.*—Henry Ward Beecher

Bath and Splash Lubrication

Third in a series of articles on lubrication fundamentals outlines these two important oiling systems

By JAMES I CLOWER
Associate Professor of Machine Design
Virginia Polytechnic Institute

BATH AND SPLASH lubrication represent two distinct systems, each applicable to particular types of equipment. Machine tools, textile machines, and many other special machines operate with their feed-transmission gears partly immersed in an oil bath contained in an oil-tight housing. Bath oiling is also employed for various bearings, such as step, suspension, spindle and thrust, and for lubrication of gears.

Bath oiling is limited to design conditions which easily and economically permit the construction of oil-tight reservoirs. From the standpoint of operation and maintenance it is quite essential that a correct oil level be maintained at all times. Too much oil causes excessive churning and agitation, resulting in excessive heat and power losses, oil leakage and deterioration. The installation of some sort of a constant-oil-level device is highly desirable in all cases.

Fig. 1 shows a typical bath-oiled ball bearing. This method is applicable to slow and moderate speed antifriction bearings. Oil level should be just sufficient to cover the balls in their lowest position. The wick-feed cup protects this bearing from over filling.

Silent- and roller-chain drives of slow and moderate speeds and of small and medium horsepower are commonly bath oiled, as in Fig. 2.

Illustrated in Fig. 3 is a bath-oiling device applied to a horizontal wire rope. A wiper on the outgoing end of the rope returns excess oil to the

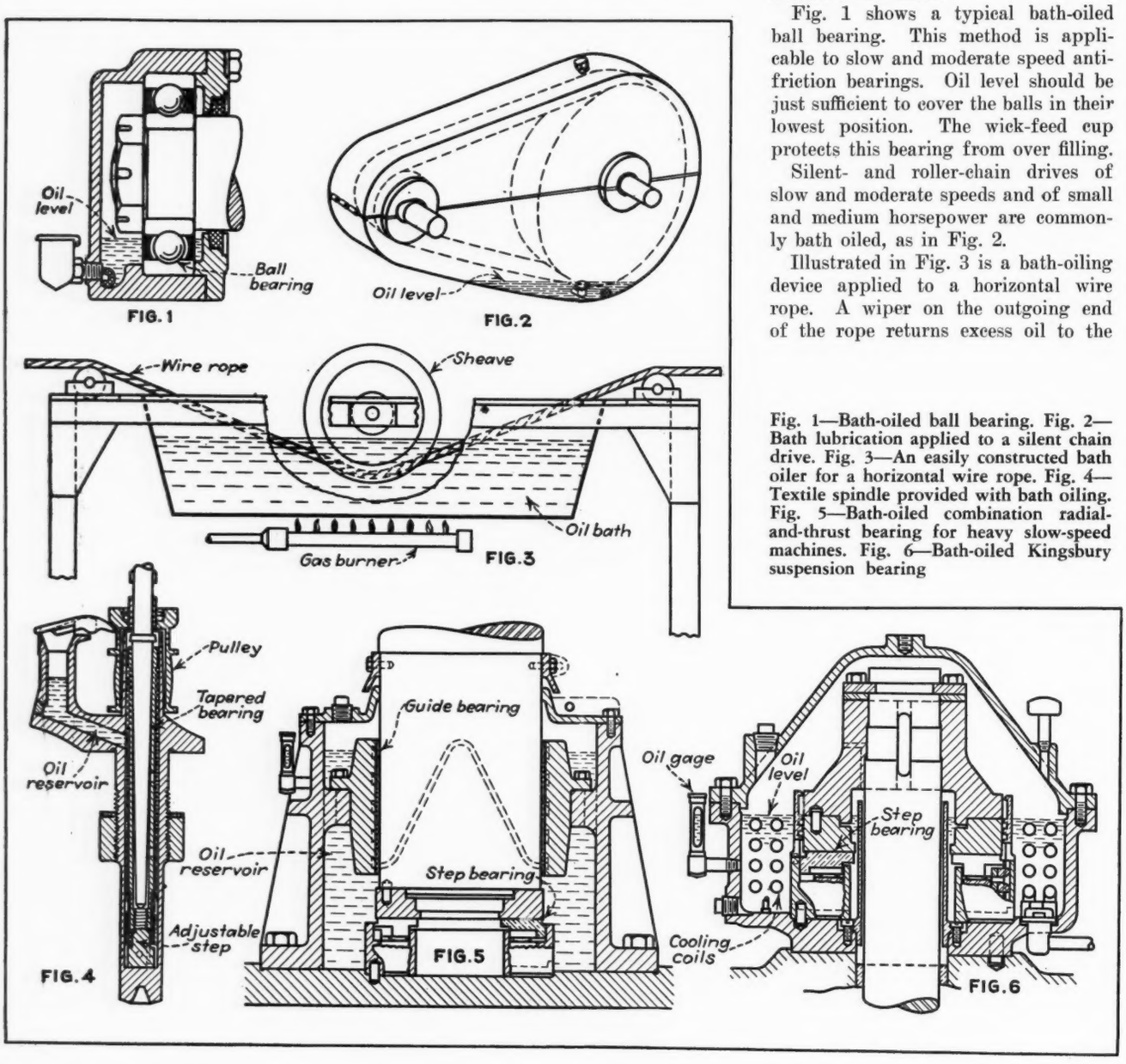
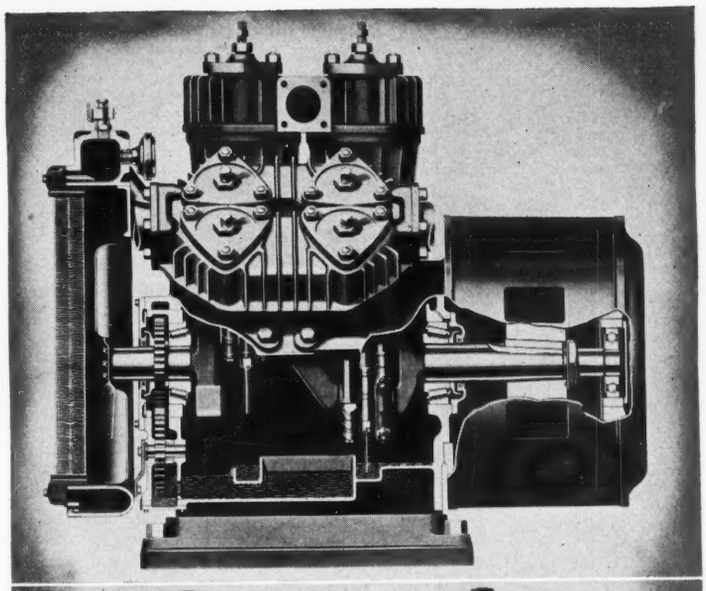
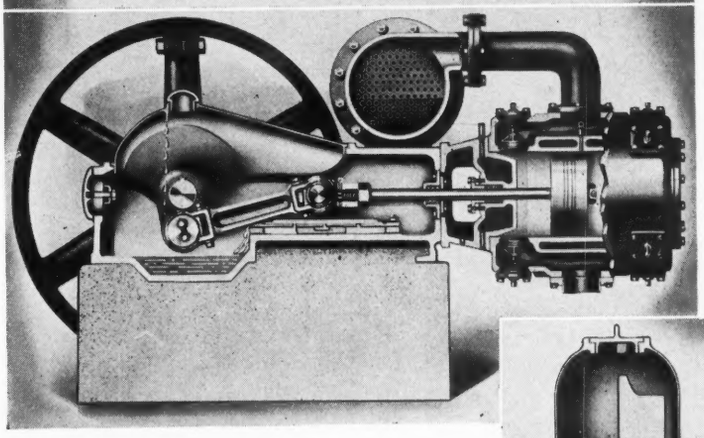


Fig. 1—Bath-oiled ball bearing. Fig. 2—Bath lubrication applied to a silent chain drive. Fig. 3—An easily constructed bath oiler for a horizontal wire rope. Fig. 4—Textile spindle provided with bath oiling. Fig. 5—Bath-oiled combination radial-and-thrust bearing for heavy slow-speed machines. Fig. 6—Bath-oiled Kingsbury suspension bearing





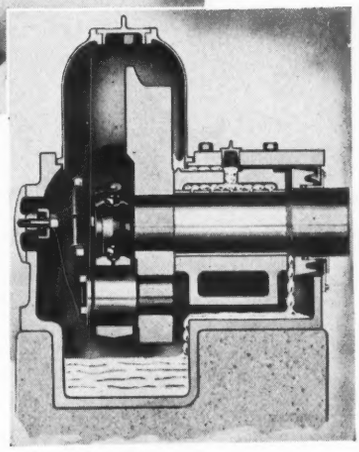


Fig. 7—(Top) Two-stage motor compressor with all bearings splash lubricated. Fig. 8—(Center) All external parts of this 2-stage air compressor are splash lubricated. Fig. 9—(Right) Section through main bearing of air compressor, Fig. 8, showing manner in which it is lubricated

bath. It is also advisable to provide a cover for the bath where it is used continuously.

A typical textile spindle bearing is shown in Fig. 4. The spindle rotates at a speed as high as 12,000 rpm in a tapered bearing called a bolster. An adjustable step is arranged at the bottom to carry the weight of the spindle and to provide a means of adjusting the clearance. As shown, the base is constructed with an oil spout for filling, provided with a hinged cover called a doffer guard. Drilled holes through the walls of the bolster permit the oil to circulate between the spindle and bolster and the bolster and housing.

Enclosed in a common housing, Fig. 5, is a thrust-and-radial bearing at the lower end of a vertical shaft. It is designed for heavy, slow-speed machinery. Both bearings are bath oiled, and a dust shield is bolted to the shaft above the housing. A sight oil gage is provided so that correct oil level can be maintained.

A Kingsbury suspension, bath-oiled thrust bearing, Fig. 6, designed for high speeds, is provided with a cooling coil. This unit is self-contained; it is separate from the frame of the machine and not a part of it.

Bath oiling is economical and requires very little attention, except a periodical draining of the reservoir and refilling with fresh, clean oil. The maintenance of the correct oil level is very important; hence a frequent inspection of oil level should be made.

Splash oiling is commonly used for machinery having cranks, bearings, and gears enclosed in oil-tight housings, which are utilized as oil reservoirs. Moving parts dip into and splash the oil in a sheet or spray into the bearings or into channels from which it flows by gravity to the various parts requiring lubrication. Connecting rods are frequently provided with a scoop, which directs and increases the spray.

Adequate lubrication is assured with this system as long as the oil level is correctly maintained, and the parts are properly fitted. Because of the constant and rather severe agitation of the oil, emulsification, if water is present, and oxidation of the oil are promoted.

If water is present in a splash-oiling system, it must be regularly and frequently removed, preferably by means of an automatic device. Otherwise it will raise the oil level, thereby causing excessive churning, which affects the splash.

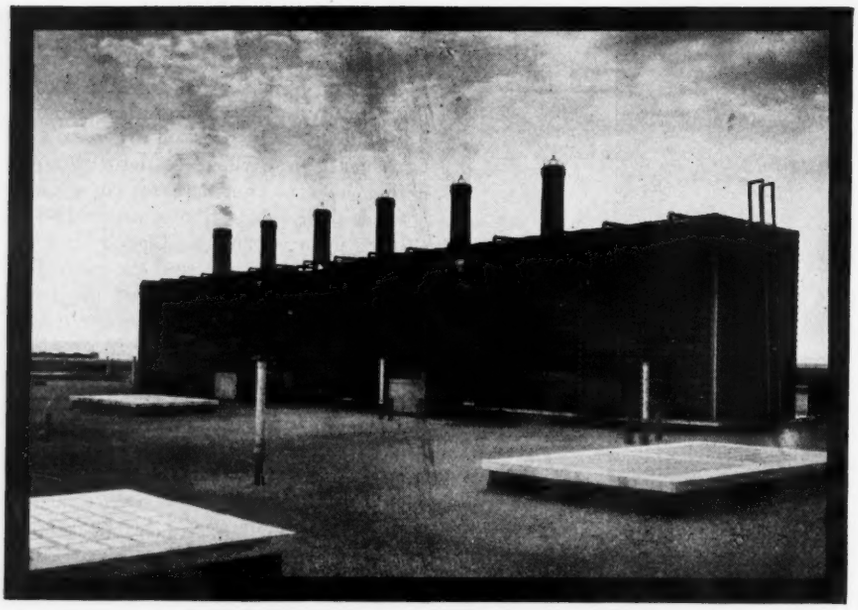
In the operation of any splash-oiling system, it is important to maintain the correct oil level. Carrying the oil level too low results in insufficient lubrication while excessive churning and heating of the oil is caused if the level is too high. Care in maintaining the correct oil level tends to promote better lubrication and longer oil life.

In Fig. 7, a 2-stage, air-cooled motor compressor has all parts splash lubricated except the pilot ball bearing. An ingenious arrangement of troughs in the crankcase, which serves as an oil reservoir, keeps the oil level in the troughs constant regardless of the quantity of oil in the crankcase. The lower large gear at the left dips into and lifts the oil from the crankcase and splashes it into a longitudinal trough from which it flows to the transverse troughs.

Compressor Lubrication

With air compressors, it is particularly important to provide just the correct amount of lubricant to the pistons and cylinder walls. Over-lubrication causes excessive cylinder deposits which in turn cause over heating, ring sticking, valve leakage, fires, and in extreme instances, explosions. So, it is essential that some means, such as the troughs, Fig. 7, be provided to insure the correct amount of splash to the pistons and cylinder walls.

Fig. 8 shows lubrication features of a 10-in. stroke, 2-stage air compressor. The main bearings, crank and crosshead pins, and crosshead guides are lubricated by oil splash. The counterweight strikes the oil in the sump each revolution and splashes it into troughs from where it flows to the various bearings, as in Fig. 9. All oil splashed is returned to the sump and used over and over. A special bulkhead, with wiper rings, keeps crankcase oil out of the cylinder. Air cylinders are oiled by a force-feed lubricator, driven from the main shaft.



Stacks of the 59th St Station, Interborough Rapid Transit Co, silhouetted behind Sheffield's new cooling tower

Sheffield Makes Steam, Buys Power

Sheffield Farms Co's new milk station in New York, N. Y., commands attention of engineers because of its all-around plant that combines refrigeration, power, heating and process in an unusual pattern

DEPARTING from the usual pattern, Sheffield Farms Co's new milk station on 57th Street, New York, N. Y., combines purchased power for refrigeration and processing equipment with an automatic low-pressure boiler plant supplying process and building heating.

Since flow of milk through a pasteurizing, bottling and delivery plant is essentially a continuous process, reliability of power supply was a prime consideration in designing the power system. The old milk plant was served by three 500-kw transformers, tied directly to the Consolidated Edison Co's high-tension feeders. Two of these have been retained, and two new transformers of the same capacity are operated in conjunction with them. Both old and new units are interlocked with low-tension feeders. Two 4000-amp enclosed copper buses run from the Edison Co's vault to the new plant-service switches, and the old 3000-kw service switch will continue to supply power and light to the office building and the garage. As additional protection against failure of main source of power, low-tension street connections have been made to the new service.

Two new Pringle 4000-amp service switches are mounted in the center of the upper level of a free-standing, double-deck switchboard of dead-front construction. This main board is 35 ft long, 13 ft 8 in. high and 7 ft deep; provision is made for lateral expansion. The upper level, reached by stairs in the center accessible from doors at either end of the lower section, controls all lighting and power requirements of the building. The lower level consists of a gageboard, auxiliary engine-room switches, elevator switches, six synchronous-motor-starting panels, and an exciter panel.

Conduit Concealed

Exposed conduit on ceilings is practically eliminated by installation in the concrete slab below the waterproof membrane. Power and lighting panels are flush-mounted in banks on pipe and vent shafts; conduit runs enter the shaft between panels so connection can be made either up or down. The small branch conduits from the power panels terminate at the far end in specially constructed boxes which project through the slab, permitting extension of the conduit at some later date, if so desired.

Present connected load is about as follows: 50% refrigeration equipment and engine- and boiler-room auxiliaries, 27% lighting and building power, 14% motor-generator sets for truck-battery charging, and 9% conveyors and other processing equipment.

Refrigeration

Total refrigeration capacity is approximately 600 tons, divided as follows:

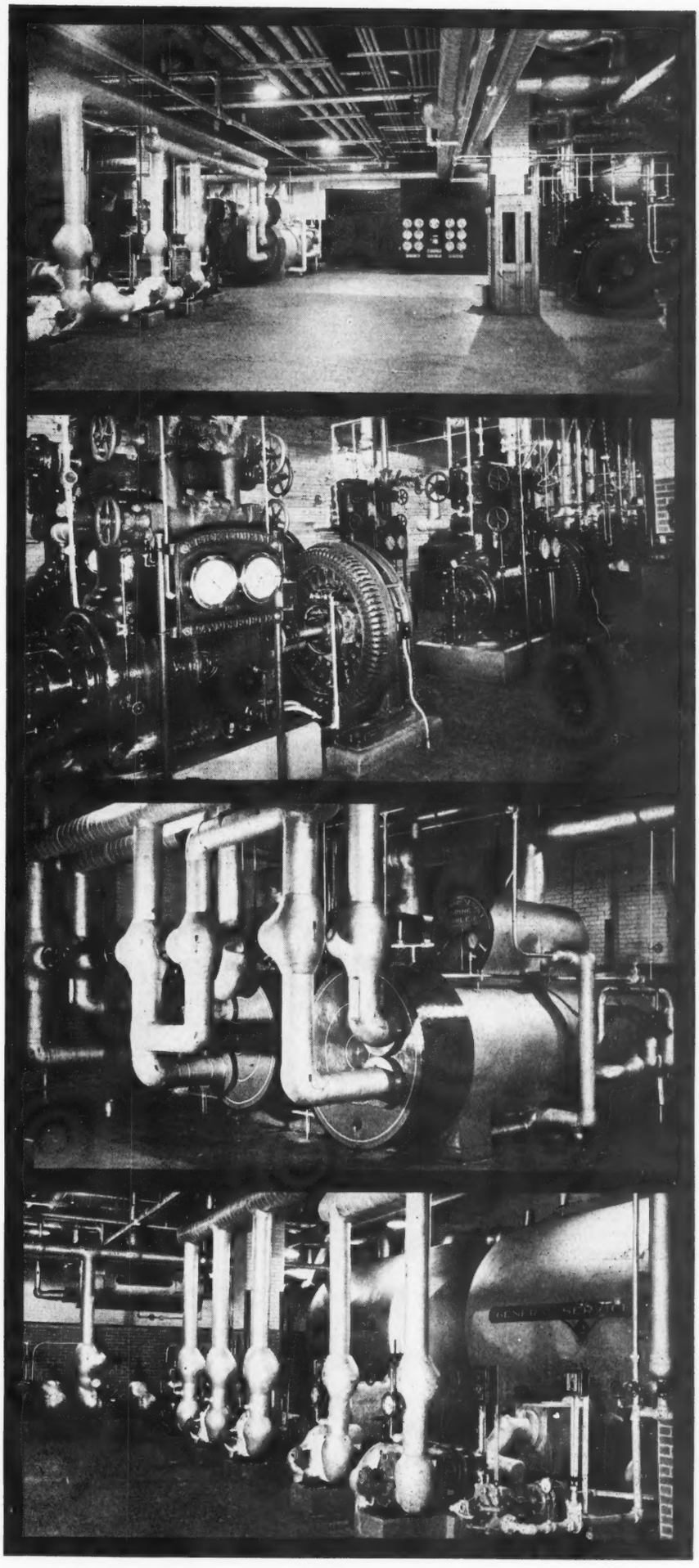
Two 10x10-in., vertical, twin-cyl, single-acting enclosed Frick ammonia compressors, both direct connected to a single 225-hp Electric Machinery Mfg Co synchronous motor, operating at 208 volts and 277 rpm.

Two 10x10-in., vertical, twin-cyl, single-acting enclosed Frick ammonia compressors, each directly connected to a 125-hp, 208-volt, 277-rpm EM synchronous motor.

Two 9x14 in., horizontal, 2 cyl. double-acting Ingersoll-Rand ammonia compressors, each directly connected to a 200-hp, 220-volt, 257-rpm, EM synchronous motor.

The total refrigerating effect of 600 tons is employed as follows: (1) making 100 tons of cake ice per day, (2) cooling brine to 10 F to make 60 tons of Flakice, (3) cooling brine to 10 F for circulation through refrigeration-box coils and unit coolers, at the rate of 60 tons per day, and (4) cooling water to 34 F for circulation through milk cooler, bottle washers, air-condi-

Top: General view of engine room showing compressors (right), gage board at far end, and brine coolers and storage tanks (left). Other three photos are closeups of (1) compressors, (2) brine coolers, and (3) brine storage tanks and pumps



tioning equipment, and for supply to cake-ice tanks, at the rate of 320 tons per day.

All brine is cooled with an ammonia backpressure of about 20 lbs, and water with a backpressure of about 40-45 lb. Two separate suction headers are connected, with proper valving to all compressors.

A closed water circuit with a Binks natural-draft cooling tower condenses ammonia vapor. There are four horizontal 10-pass shell-and-tube condensers, each 38 in. in diameter by 18 ft long, with 158 2-in. tubes in each. The ammonia receiver is horizontal, 30 in. in diameter and 18 ft 6 in. long, and there is a shell-and-tube ammonia liquid cooler that cools all liquid coming from the receiver under high backpressure.

Condensing Circuit

Three condensing-water pumps, capacities of 300, 600 and 900 gpm, deliver water to the cooling tower; automatic valves take care of makeup, representing less than 1% lost by drift and evaporation. Condensing circuits are protected against slime and corrosion by Kirkaldy electrolytic system.

Three brine coolers in the engine room supply brine to Flakice machines, refrigerated boxes on the loading platforms, and cake-ice and Flakice storage boxes. Two of the coolers are 10-pass units, 38.75 in. OD and 15 ft long, with 148 2-in. tubes; the other is also a 10-pass unit, 42 in. OD and 14 ft long, with 172 2-in. tubes.

Flakice Machines

Six Flakice machines are arranged in pairs on the third floor, with additional foundations and floor openings for two more. Insulated wood enclosures cover each pair, with hinged covers and plug doors for access to all parts of the machines. Two 8-in. brine mains connect these machines with the calcium-chloride brine-storage tank in the engine room. Machines discharge through chutes into storage boxes below.

Refrigerated boxes on the loading platforms have a total area of 8640 sq ft. Each of the four is equipped with a single, floor-mounted dry-surface unit cooler, designed to hold box temperature at 40 F. Ice-storage boxes are kept at 25 F by 1¼-in., wrought-iron, galvanized-pipe coils. An 800-cu-ft brine-storage tank in the

engine room holds calcium-chloride brine for general service.

The 120 x 22.5-ft ice field contains 1040 300-lb cake-ice cans. It is divided by a watertight partition to permit operation of half the field when the other half is out for repair. One horizontal, single-pass shell-and-tube brine cooler, 46.75 in. OD and 16 ft 6 in. long, with 266 2-in. tubes, serves each half of the field.

The ice-making tank contains approximately 3200 cu ft of calcium-chloride brine. Water is supplied to the ice field at slightly above freezing temperature, and this precooling is estimated to increase the capacity by about 15%.

Battery Charging

Delivery trucks operating out of this station are both electric and gasoline driven. The latter represent an experiment to find out if the lower first cost of gasoline vehicles balances expected higher operating costs on short city runs. If it doesn't, the gasoline trucks will be shifted to suburban routes. About 350 hp of motor-generating equipment is on the second floor, for battery charging. To overcome low inherent efficiencies when operating mg sets at light loads, sets of various sizes have been installed so that the operator can switch generators or change the combination as demand varies. The mg-set load is an important factor in balancing total load, since battery-charging rates can be varied and time of charging altered.

Two 3-drum, bent-tube Wickes boilers, each with 3016 sq ft of heating surface, generate steam at 10 lb but are designed for possible future operation at 250 lb. All drums are welded; the two mud drums are supported by steel columns independent of the brickwork. The steam drum, 48 in. dia. by 17 ft 6 in. long, is supported by the tubes from the mud drums.

Boilers discharge into breeching leading to a radial-brick chimney, which has its base in the boiler room. Total stack height is 140 ft, about 65 ft being above the building roof. Inside diameter at top is 5 ft 6 in.

Oil firing was selected for two reasons: (1) there is no room in this first building for coal storage, and (2) oil offered the possibility of automatic operation at low steam pressure. As installed, oil-burning equipment requires no attention except lighting burners.

Oil-Burning Equipment

Each boiler has three horizontal rotary Todd oil burners, each with a capacity of 90—450 lb of oil per hr. Burning No. 6 oil, these burners will carry boilers to 200% rating. Oil is fed to burners by one of two 300-gpm slow-speed rotary oil pumps, the other pump serving as standby. Oil is heated to 180 F in one of the two steam heaters, either being capable of handling 200% rating. An electric heater is used for starting up, when no steam is available.

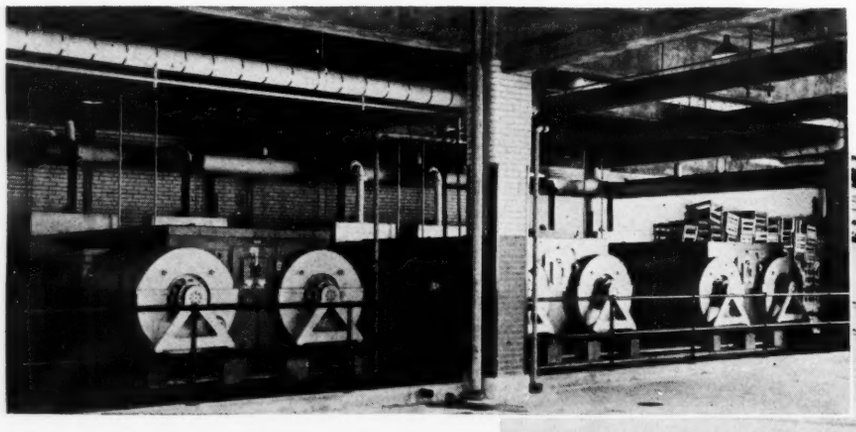
Combustion efficiency is maintained over a wide range of loads by Cash regulators; one controlling furnace draft, the other oil flow and fuel-air ratio. Automatic safety devices shut down burner motors when steam pressure exceeds a safe limit, when low or high water occurs or in case of accidental flame failure.

Control System

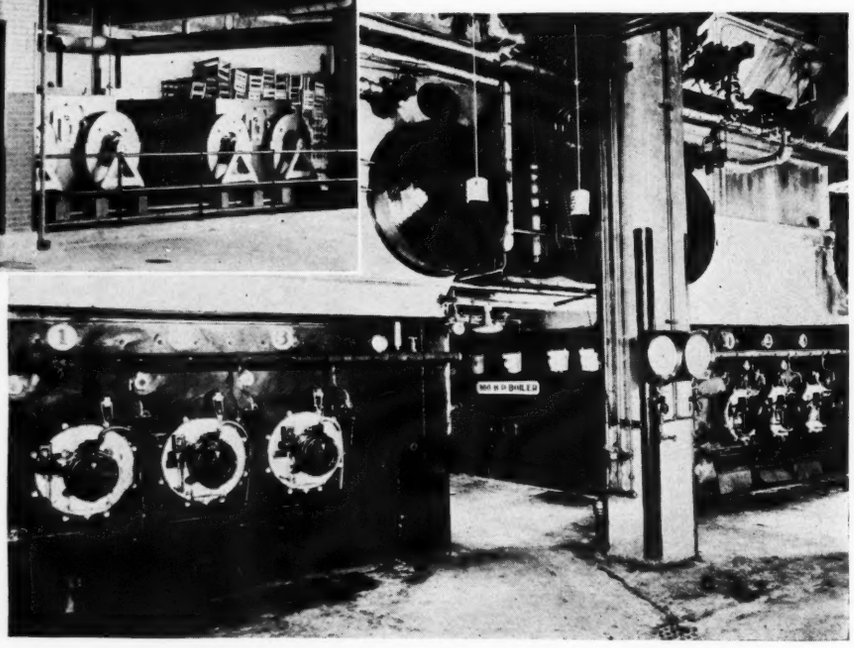
A comprehensive system of signals and alarms allows the boiler plant to be operated by the engineer ordinarily stationed in the engine room. The signal system is centralized at the gage board previously mentioned as part of the main switchboard. It contains indicating lights for (1) oil burners, (2) smoke, (3) boiler pressure, (4) air pressure, (5) reception-room air-conditioning fan, (6) main supply fan No. 1, (7) main supply fan No. 2, (8) exhaust fan No. 3, (9) exhaust fan No. 4, (10) fresh-air unit heater, (11) brine-tank agitator No. 1, (12) brine-tank agitator No. 2, (13) Flakice machines, (14) Flakice brine, (15) general-service brine, and (16) high-pressure ammonia.

Alarm Signals

Alarm-bell and indicating-light signals are combined in an ingenious sequence to keep the engineer on duty aware of conditions in all parts of the plant, at all times. Thus, when operation is normal, the bell is silent and the lights are out. If trouble develops, the alarm bell rings and the location of the difficulty is shown by a glowing signal light. The light continues to glow until the condition is remedied, then the alarm bell rings again, and the light goes out.



Flakice machines have insulated housings



Bent-tube, oil-fired boilers, now operated at 10 lb, are designed for 250 lb

In addition to indicating lights, the gage board contains the following flush-mounted instruments: gages for h-p and l-p ammonia-suction pressure and ammonia-discharge pressure; recorders for h-p and l-p ammonia-suction pressures; 4-pen recorder for wet-bulb temperature, water to and from condenser, and ammonia head pressure; recorders for ice water and hot water; house tank gages, steam pressure gage; outside temperature recorder; electrical demand meter; and clock.

Additional boiler-plant instruments are mounted on a panel in the boiler room. Republic meters and gages indicate and record steam flow, feedwater flow, and flue-gas temperature, and indicate furnace draft for each boiler. Percentage of CO_2 in the flue gas is indicated and recorded for each boiler by two Permutit Ranarex units. Smoke conditions are shown by an ESS Instrument Co indicator.

Heating and Ventilating

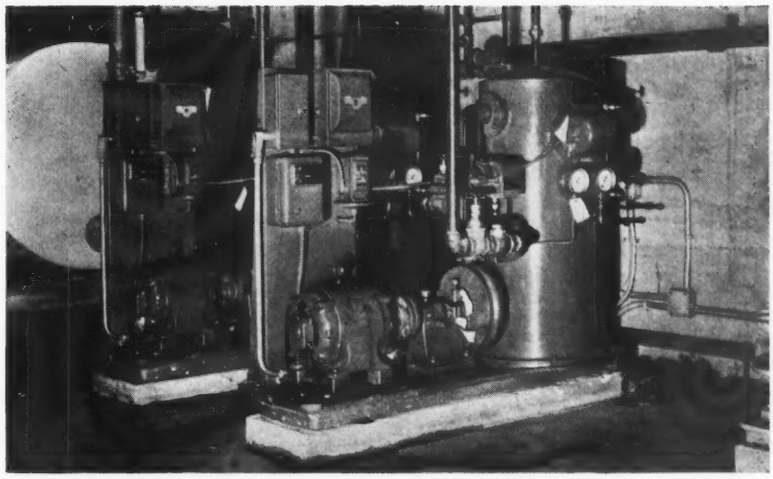
Unit heaters, taking steam from a 10-lb main, heat garage areas; radiators, operating on a sub-atmospheric system, handle office heating.

A Dunham sub-atmospheric control valve reduces steam pressure and controls temperature and amount of steam going to radiators. Each radiator (ARCO) is equipped with an adjustable orifice valve and a thermostatic trap. Returns are handled by a Dunham duplex differential pump. This system permits even heating regardless of distance of radiator from boiler, gives accurate control of heat emitted from radiators on even the mildest days, and avoids excessive fluctuations in radiator temperatures.

Tempered, filtered air is supplied to pasterurizing and bottling rooms, reception room, and a portion of the office and basement areas. Most of the load is carried by the main supply unit, rated at 41,400 cfm. Pneumatic controls, by Johnson Service Co, open and close intake damper when fan motor starts and stops; thermostats in fresh-air inlet and supply duct regulate steam flow to heating coils to hold temperature at 60 F.

Conditioning Units

A 4100-cfm conditioning unit supplies the reception room. By manual control from the reception room, the unit can be made to pass all fresh air or part fresh air and part recirculated air. Thermostats in the fresh-air intake, in the supply duct, and in the reception room, maintain the desired temperature, controlling flow of steam to heating coils. Humidity is held to proper limits by a humidostat regulating flow of ice water to cooling coils in the unit.



Two sets of vacuum pumps serve sub-atmospheric heating system

A separate unit, 5700-cfm capacity, supplies fresh air to the tank scale room, can-storage room, and engine room, in the basement. Temperature is regulated by bypassing air around the heating coils, under control of a thermostat in the supply duct. In warm weather this unit furnishes filtered fresh air to the basement rooms.

Exhaust fans, of 31,000, 7500, and 5300 cfm, are equipped with vortex dampers which open and close with starting and stopping of fan motors. One has a static-pressure regulator. Filters are of the dry type, made by American Air Filter Co. A Worthington $4\frac{1}{4}$x$2\frac{3}{4}$-in. twin cyl, single-stage compressor supplies air for operating pneumatic controls.

Water Heating

Two separate systems supply hot-water requirements of this station. General service hot water, for cleaning equipment, the building, and for sinks and lavatories, comes from a Patterson-Kelley solid Everdur storage heater containing a U-tube element made up of $1\frac{1}{4}$-in., 16 BWG copper tubing. This unit heats 100 gpm from 40 to 180 F, and the shell, 42 in. in diameter and 14 ft long, will store 900 gal. A smaller storage heater, rated at 16 gpm, from 40 to 180 F, and with a storage capacity of 200 gal., supplies hot water to the office building. Steam to heaters is thermostatically controlled.

Hot water for pasteurizing circulates in a closed system. Two instantaneous heaters are mounted above a 760-gal. storage tank, which they supply, and from which hot water flows to the milk heaters. The instantaneous heaters are each capable of heating 76 gpm from 99.5 to 208.5 F. They are Patterson-Kelley, U-tube, 4-pass units, with steel shells 15 in. in diameter and 9 ft. 4 in. long, and containing 212 sq ft of $\frac{3}{4}$-in. OD, 18 BWG copper tubing. Tube sheets and water boxes are Everdur, as is the storage tank.

Scheduling Load

That the combination of purchased power and steam generation at low pressure proves most economical in this plant is due principally to two factors. In the first place, designing the boiler plant for practically automatic operation at low pressure permits the engineer on duty in the engine room to run the boiler room as well. Only maintenance labor is required. In the second place, electric operations are carefully scheduled to avoid peaks, with consequent savings in power bills.

Each month the management determines what the maximum loads should be, based on careful schedules. A recording demand meter indicates when these figures are exceeded. Under typical conditions, trucks are charged from noon to 6 p.m. and during this time some of the refrigeration equipment is shut down. Pasteurizing load comes on about 8 p.m. and continues until about 4 a.m., and during this time no batteries are charged and only a few Flakice machines are operated. From 6 a.m. on, all Flakice machines are running and the ice field is at capacity. However, the only load during this period is refrigeration.

Future Possibilities

High-pressure boilers give maximum flexibility for future operation. If electric load should grow considerably, it might be more economical to install some steam-driven equipment, using exhaust for building and process heating. Should electric rates change unfavorably going to high pressure would permit power generation, making exhaust available for process and heating.

Turbine Trends

What would a fashion show of this year's turbines exhibit? Tops or condensing, 3600 or 1800 rpm, how about pressure and temperature, hydrogen cooling? Here is an authoritative review of the trends in units over 10,000 kw

By W E BLOWNEY
General Electric Co, Schenectady

ACCOMPANYING CHARTS show the progress toward improved operating conditions based on a comparison of large turbines bought during the past four years with those purchased during the last four years in the 1920's. All turbine orders, exclusive of those for marine propulsion, received by General Electric Co for the years 1926 to 1929 and 1935 to 1938 in sizes 10,000 kw and larger, were used in making the analysis. A few superposed and condensing turbines smaller than 10,000 kw were included in the earlier period.

In Fig. 1, it is interesting to note that the average rating of the 1800-rpm turbines sold in 1926-1929 is 20,000 kw less than for 1935-1938 even though the earlier period was supposed to be the era of the large turbine. The increase in ratings of 3600-rpm turbines in 1935-1938 is striking and it will be noted that the average rating for this period is twice the maximum at this speed for 1926-1929.

Average Turbine Size

The average size of all turbines 10,000 kw and larger sold in 1926-1929 (exclusive of marine) was 35,300 kw and for 1935-1938 it was 35,200 kw. This may seem like a coincidence but other studies indicate that this value has not changed greatly over the past two decades.

Fig. 2 was prepared to show the substantial increases in initial steam temperature that have been made possible since 1929 by a better understanding of properties of alloy steels.

In Fig. 3, the great increase in 1200-1250-lb usage and the new 800-850-lb pressure range in 1935-1938 are significant. Fig. 4 was prepared to show the range of capacities of turbines being sold at these two pressure ranges. The increase in average capacity and temperature as the pressure is increased is what would be expected.

Figs. 5 and 6 should be considered together in order to get a true picture of changes that have been taking

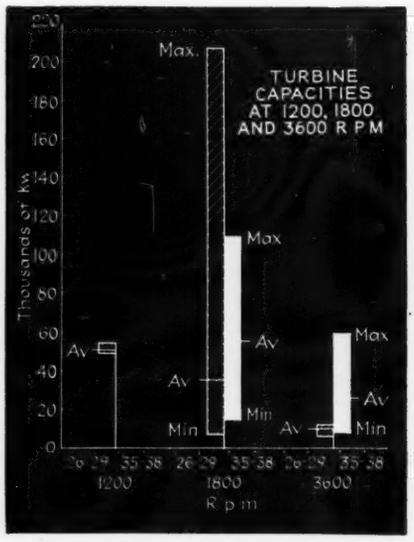


Fig. 1—Turbine capacities at 1200, 1800 and 3600 rpm based on all General Electric turbine orders (10,000 kw and larger) from 1926 to 1929 and from 1935 to 1938

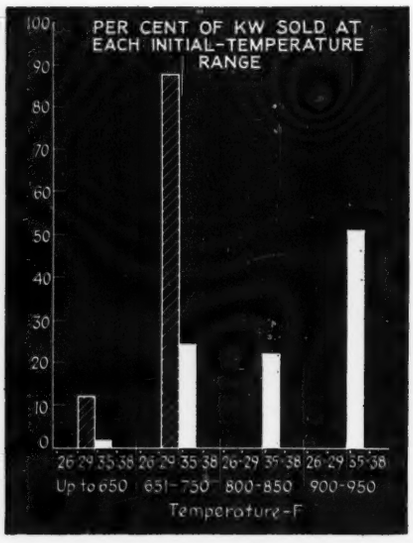


Fig. 2—Initial temperature of turbines sold from 1926-1929 and 1935-1938. From the same data as Fig. 1

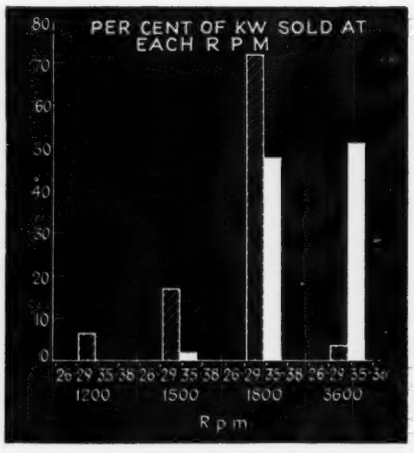


Fig. 5—Speed of turbines sold from 1926-1929 and 1935-1938. Ordinate in this case is "percent of kw sold"

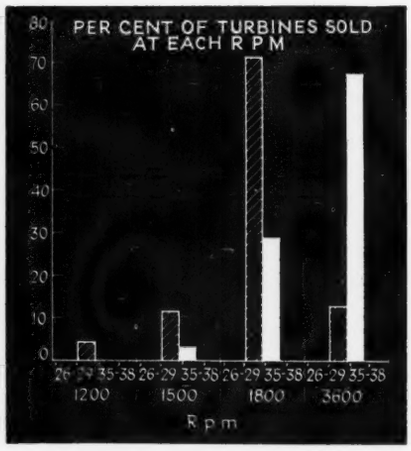


Fig. 6—Same as Fig. 5 except that ordinate is "percent of turbines sold". Note change in 3600-rpm values

place in turbine speeds. Approximately an equal number of kilowatts have been sold during 1935-1938 for 1800- and 3600-rpm operation, although a much greater number of 3600-rpm turbines have been sold. This bears out the data given in Fig. 1 that the average size of 3600-rpm turbines is much smaller than for 1800-rpm. Progress towards standardization at 60-cycle frequency in recent years is apparent from these two charts.

In studying Fig. 7, it should be remembered that for every kilowatt of superposed turbine installed, sufficient steam is discharged from the exhaust to produce one to three kilowatts more in the low-pressure turbines. Only true superposed turbines were counted in preparing this figure—in other words, the high-pressure turbines of cross- or tandem-compound turbine sets were not included.

The data shown in Fig. 8 are particularly interesting. By 1935, ten years of experience had shown that the superposed turbine was practical and offered a highly desirable method of improving the economy of old low-pressure stations. During the depression, careful studies had been made of a number of possible applications and as soon as business conditions made it possible, a number of superposed turbines were ordered in 1935. During the past three years the percentage of kilowatts for condensing operation has increased to what is probably a more nearly normal figure. Results from recent installations of superposed turbines are gratifying and indicate that expected large reductions in station heat rates are being realized.

The data used to prepare Fig. 9 do not include the 150,000-kw State Line generator which was not purchased during either period but was rebuilt and has been using hydrogen cooling in the generator for the past twelve months. The first hydrogen-cooled generator (Dayton) was placed in service on Oct. 12, 1937, and within a year there were more than 400,000 kw of generators actually operating in hydrogen.

There has been a great increase in the proportion of kilowatts sold with hydrogen-cooled generators (see Fig. 10), although it may be noted that, due to business conditions, the actual number of kilowatts sold in 1938 has been somewhat less than for either of the preceding two years.

Fig. 11 shows the volume of hydrogen-cooled-generator sales in each of these years. This amplifies the data given in Fig. 10.

Fig. 12 is particularly interesting because of the marked similarity between the two sets of data. There was practically no change in condensing-turbine exhaust pressures during the

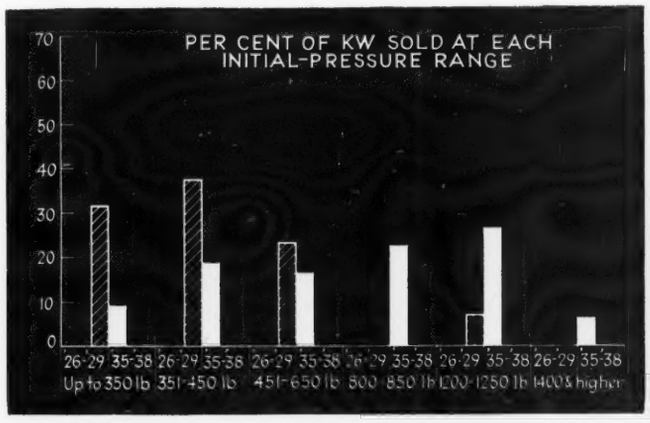


Fig. 3—Initial pressures of turbines sold from 1926-1929 and 1935-1938. From same data as Fig 1

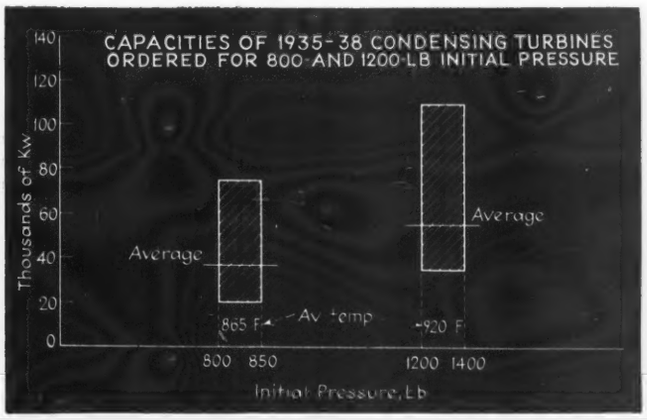


Fig. 4—Capacities of condensing turbines ordered for 800- and 1200-lb initial pressure. From the same data as Fig. 1

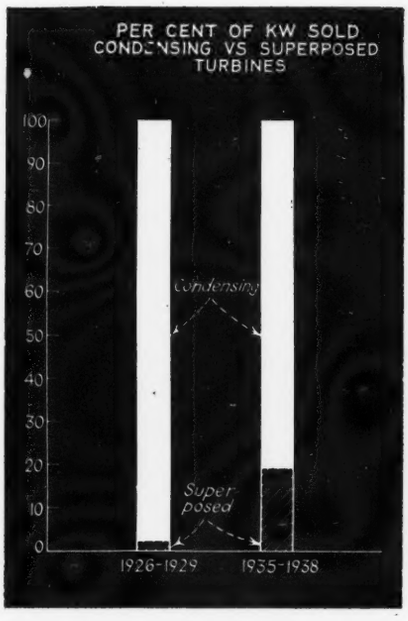


Fig. 7—Superposed and condensing turbines sold during 1926-1929 and 1935-1938. From same data as Fig. 1

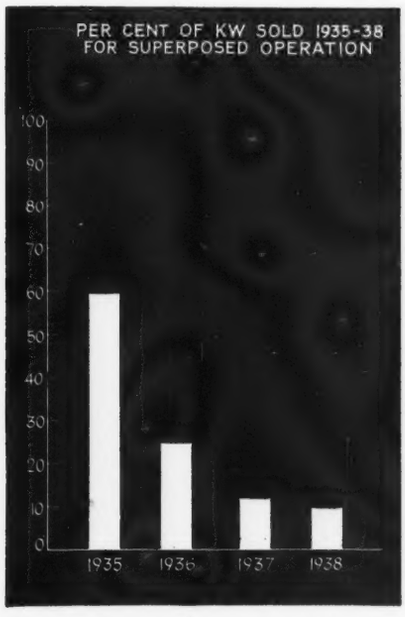


Fig. 8—Superposed turbines sold each year from 1935-1938. From 1935-38 data used in Fig. 1

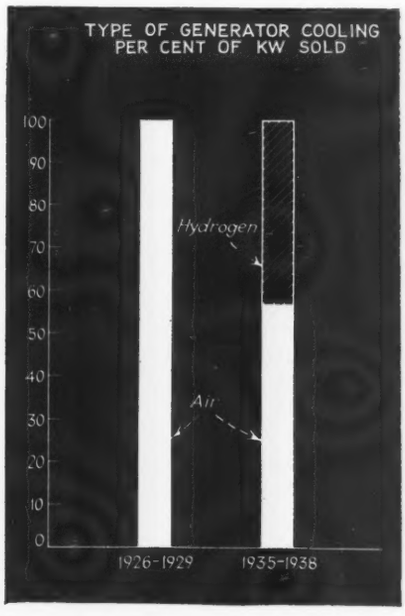


Fig. 9—Type of generator cooling sold from 1926-1929 and 1935-1938. From same data as Fig. 1

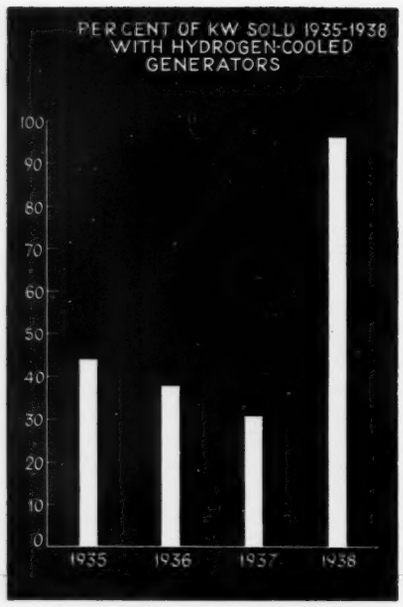


Fig. 10—Hydrogen-cooled generators (based on percent of kw) sold each year from 1935-1938. From same data used in Fig. 1

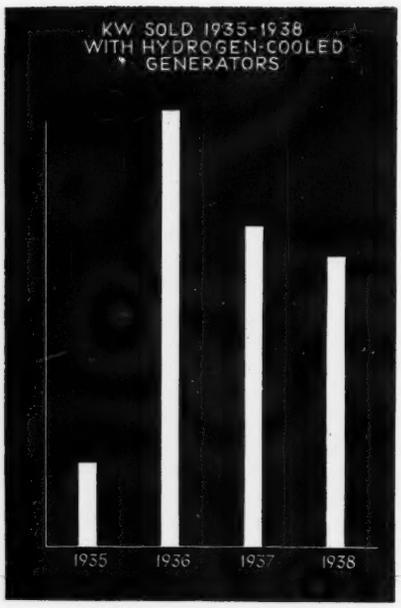


Fig. 11—Same as Fig. 10 except that ordinate is absolute value of kilowatts sold for hydrogen operation during each of the four years

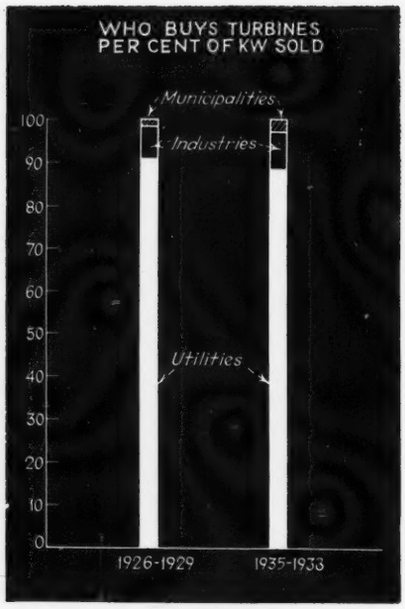


Fig. 12—Percent of kilowatts sold to utility, industrial and municipal power plants during 1926-1929 and 1935-1938. From the same data as Fig. 1

two periods studied and it is not considered worth while to attempt any comparisons.

Resuperheating was popular during the 1920's and some of the most efficient stations of that period used this method. The resuperheating cycle made it possible to reduce moisture content of steam in the low-pressure stages and thereby increase the turbine efficiency. A simpler method of reducing the moisture content was made available by use of 900-950-F initial steam temperatures instead of the earlier 750 F.

In recent years there have been no resuperheating turbines sold for stations having steam pressures of 1200 lb and lower. With initial pressure higher than 1200 lb and with 950-F maximum initial temperature, moisture content in the low-pressure stages begins to increase and the need for resuperheating reappears. The 2400-lb, 940-F steam turbine now being built for Twin Branch has resuperheating to 900 F between the high- and low-pressure turbines.

No data are included with regard to extraction of steam for feedwater heating. The practice was common during both periods studied and it will undoubtedly continue as it is a simple method of improving heat balance. There has, however, been a tendency to use more heaters recently.

✦ ✦ ✦

Swinging Chute Beats Hopper Segregation

By ARTHUR K SPOTTON

SEGREGATION in chute-fed hoppers on chain-grate stokers at the plant of Babcock-Wilcox and Goldie-McCulloch Ltd, Galt, Ontario, is eliminated by the arrangement illustrated. A drum with a double screw carries a nut connected to the lower end of a swinging coal chute. When the drum rotates, the nut travels back and forth across the boiler front. This motion of the coal chute produces an even distribution of coal sizes over the full width of the hopper. The device is covered by both Canadian and American patents.

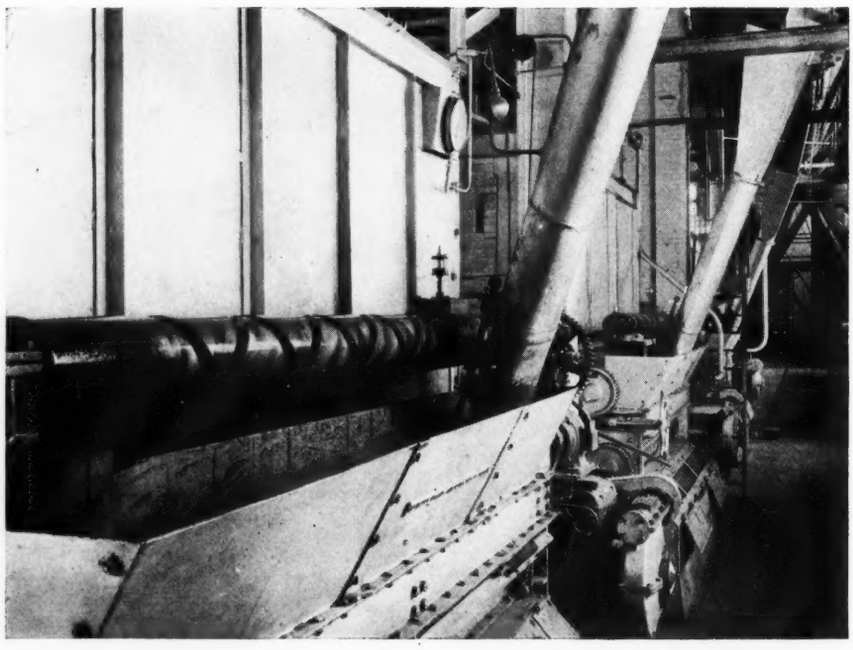


Fig. 1—Belt-conveyor system takes coal from trucks, railway cars or reserve storage and delivers it to boiler-house bunkers

Coal Handling at West End Station

Cincinnati Gas & Electric Co put in a new 250-ton-per-hr coal-handling system to supply old and new boilers and did it without interfering with plant operation

By H V SCHIEFER
The C O Bartlett & Snow Co

ADDITION of a new superposed turbine-generator and replacing old stoker-fired boilers with pulverized-coal-fired units presented several unusual problems at Cincinnati Gas & Electric Co's West End Station, built in 1916. One of them was an adequate coal-handling system for the rebuilt plant.

The station, in a business district near the center of Cincinnati, Ohio, has greatly restricted property limits, which made necessary fitting the new coal-handling system to fixed building dimensions, to established yard levels and bunker elevations, and to concrete storage yard, conduit tunnels and railroad tracks that were in place. In addition, it was necessary to keep the plant operating while alterations and additions were being made.

The old coal-handling system was simple, and operated satisfactorily at low cost for many years. It was quite dusty, however, and coal dust traveled to all parts of the plant, but had not been serious with the old equipment. With the new turbine, boilers, instruments, etc, a clean boiler room was not only desirable, but essential.

West End, being on the bank of the Ohio River, is subjected to floods and high-water stages that last sometimes for a week. At extreme flood stage, all railroad tracks in the vicinity are submerged and, because of the swift river current, it is impractical to get coal to the station in river barges. It is, therefore, necessary to store coal for flood periods, and to have it available for use when needed.

Coal for the station is normally brought down the Ohio River in barges by the Ohio River Co. This company's river unloading equipment is a few hundred yards down stream from the station, with a manufacturing building between. Barges have a capacity of about 1000 tons each, and are unloaded by barge-mounted grab buckets, discharging onto a movable inclined conveyor that in turn discharges into bunkers at the top of the river bank, on Ohio River Co property.

From River to Plant

Standard automobile trucks transfer coal from these bunkers to a double-track hopper at the power plant, Figs. 1 and 4. Trucks travel less than a quarter of a mile from bunker to track hopper, part of which is over a city street, and deliver about 250 tons per hour. The track hopper, about 45 ft long, has ample room for two trucks to maneuver and dump simultaneously.

Normally, coal for current use is discharged into the track hopper by trucks. A railroad track is over the hopper, so that coal can be brought to the plant in railroad cars when necessary. Coal for storage at the plant is discharged either into the track hopper or into an adjacent pit from trucks or railroad cars. It is then placed in storage by the old gantry crane and grab-bucket.

Coal is usually fed from the track hopper, conveyed and elevated to the

crusher house, and after being crushed to ¾-in. size, is elevated and conveyed to a horizontal belt conveyor under the roof of the boiler room, passing over a 36-in. magnetic-separator-head pulley of conveyor No. 3 enroute. If there is an interruption to the regular receipt of coal by trucks, it can be supplied to the bunkers by withdrawing from storage and discharging to the track hopper with the gantry crane, or as described later.

Originally there were 14 stoker-fired boilers, 8 in one row, and 6 in another. Four of these boilers have been replaced with three 1450-lb, 350,000-lb-per-hr steam generators. Coal-supply hoppers above boilers No. 4, 6 and 8 were replaced with three large overhead bunkers, which now supply by gravity either these three old stokers or the pulverizers for the new steam generators.

At present, the overhead belt conveyor is equipped with a tripper that feeds coal directly into the new bunkers. Temporary chutes feed the stoker hoppers serving boilers 2, 10 and 12. Boilers No. 9, 11, 13 and 15 are fed by a cross belt and a shuttle belt, as shown in Fig. 4.

It is anticipated that in the future, three new steam generators and a superposed turbine will be installed, at which time three new bunkers will be installed, to line up with the present new ones. It will be a simple matter to extend belt conveyor No. 4, which will then serve all six bunkers. The cross and shuttle belts will then be removed, part of the former being used to make the extension.

When flood waters reach the top of the track hopper, the main supply belt and feeders under the track hopper become inoperative. For this contingency, an emergency hopper and conveyor were installed. Coal from storage is reclaimed by gantry crane and deposited into the emergency hopper, Fig. 4, from where it is taken by a reciprocating plate feeder and fed onto an emergency belt conveyor, discharged into the crusher, and thence through the regular system to the bunkers. The emergency hopper gives a second method of reclaiming from field storage at any time, thus providing spare equipment to the crusher.

Even though the receiving hopper is equipped for railway receipt of coal, it is essentially a receiving hopper for coal delivered by trucks or from storage by crane. Top area of hopper is 14 ft wide by 45 ft long. It is made of steel, and comprises two duplicate tandem hoppers, the bottoms of which are fitted with a duplex reciprocating feeder, of the double type, comprising two elements. The outer end of each element rests on wheels, and the inner end is hung on rods, giving an up and down, as well as lengthwise motion. Slope of each element is adjustable from 5 to 10 deg from horizontal. Two adjustable driving eccentrics give not only adjustment in slope, but also in the amount of throw, which affects capacity of the feeder, and consequently, capacity of the entire coal-handling system.

Fig. 2—Steel partitions and sprinkler system protect conveyor galleries

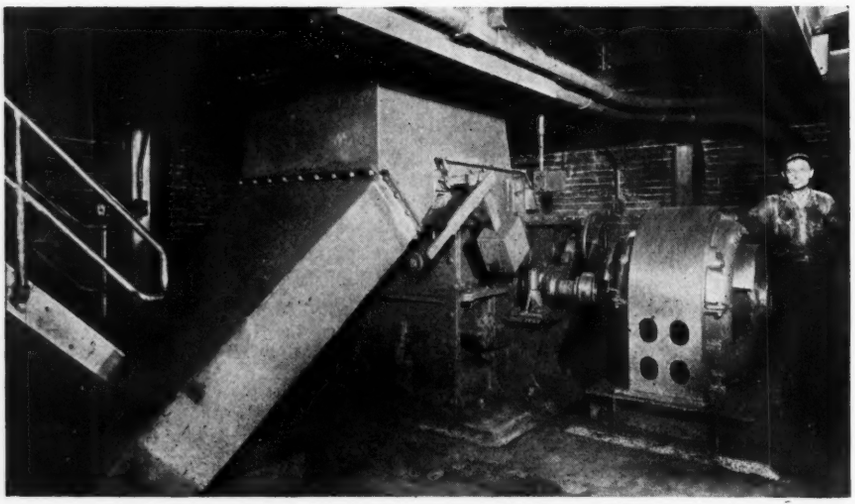


Fig. 3—Run-of-mine coal goes through this crusher and is reduced to ¾ in. size; chute permits bypassing the crusher

Conveyor Belting

The system handles 250 tons of coal per hour. Run-of-mine is taken from the track hopper to the crusher on a 42-in. belt; reclaimed coal is delivered by a 30-in. belt to the crusher. The rest of the system consists of 30-in. belts, except the shuttle belt, which is more or less temporary unit. All belts except one are standard with ⅛-in. rubber cover on the carrying side, and 1/32-in. on the reverse side, the rubber covering having from 2500 to 3000 lb tensile strength on 32-oz duck. The belt from the track hopper to crusher has a 3/16-in. rubber cover.

Because of limited ground space, and fixed location and elevations, belt-conveyor-inclination angles approach the maximum for efficient operation. Belt conveyor No. 1, handling run-of-mine coal, is on an angle of 18 deg with the horizontal. Under normal conditions, this belt is perfectly satisfactory, but when handling wet coal, or when first starting, there is an occasional slight slippage. This has never been serious nor has coal spilled from the belt, but it does demonstrate that the limit has been approached. Belt conveyor No. 2 is on an angle of about 19 deg with the horizontal and carries coal from the crusher to the boiler house.

Drive motors for all belts are totally enclosed and connected to head shafts, through gear-speed reducing units. They are mounted on 1-piece bases, which are placed on concrete pads on the floors. No. 1 belt head pulley is rubber-lagged. Drives for inclined belts have automatic, non-return mechanical backstops built as part of the speed reducers. These backstops prevent reversing of a loaded belt in event of current interruption.

At the point where coal is loaded

onto the belts, steel skirt plates shod with pure-rubber strips are used. The rubber is at an angle instead of vertical, to reduce wear at points of contact.

Idlers and Roll Ends

Standard self-cleaning idler stands and belt stringers are used. Toes of the channel stringers are turned in, and the No. 12 steel deck plating is flanged and fitted down over the channel backs. Idler frames are well above the decking, thus permitting flushing of the entire length of decking without obstruction. Standard roller-bearing carrying idlers are spaced on 4-ft centers, except at the loading points, where the spacing is closer. Three unit rolls, 8 in. in diameter for each idler, are mounted on malleable stands, with self-cleaning bases. Roll ends are machine-finished cast iron, and pressed into the tubing, flush with its ends, to eliminate possibility of holding dirt. Each roll is separately high-pressure lubricated, all three fittings being on one side of the conveyor. Return idlers are of similar construction, having a single roll 6 in. in diameter, spaced on 10-ft centers.

Instead of the usual steel-truss with corrugated covering construction, sides of the conveyor galleries are solid steel-plate girders. Fig 2. Since windows in conveyor galleries collect dirt readily, and are cleaned with difficulty, they were omitted from the galleries and the crusher house, artificial lighting being satisfactory for this service. Gallery interiors present a neat appearance, dust collection is reduced to a minimum, and the cost of cleaning is negligible.

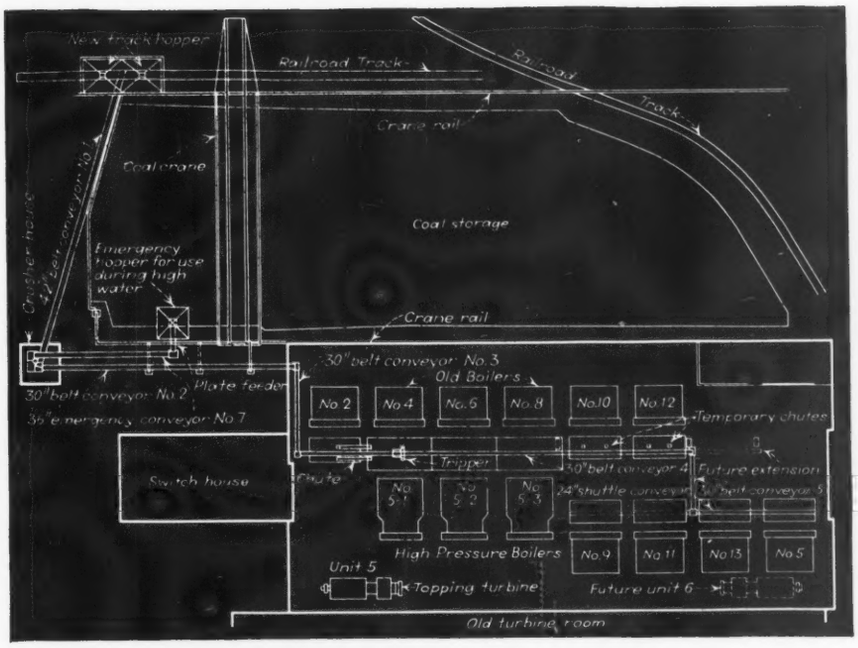


Fig. 4—Plan of boiler plant and coal-handling system

Steel partitions in the conveyor galleries, shown in Fig. 2, reduce natural draft, thus retarding spread of a possible fire. A dry sprinkler system is installed with spray heads over the carrying side of the belt and under the conveyor decking.

Distributing conveyor No. 4, over the bunkers, is equipped with a standard belt-driven, automatic, self-propelling, 3-way tripper. Of steel-plate construction, the tripper discharges coal either into the three new bunkers or places it back on the belt for delivery through temporary conveyors to the old stoker hoppers. When the future three new bunkers are installed, it will not be necessary to use the chute that places coal back onto the conveyor.

The coal-handling machinery was built and installed by C O Bartlett & Snow Co, Cleveland, Ohio under supervision of C W DeForest, vice-president, Columbia Engineering Corp, and Sargent & Lundy, Consulting Engineers, Chicago, Ill.

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Questions for Boiler-Room Engineers

THESE QUESTIONS are similar to those asked in some of the better-arranged state examinations for licenses to operate steam boilers. Use them as an aid in interviewing and selecting power-plant employees, and as a review of important features of boiler-room operating practice. From time to time POWER will publish additional questions of this type.

BY HARRY M SPRING

Q—You have two centrifugal pumps operating in parallel, and when you shut one down, its check valve causes serious shock to the piping by slamming. What would you do to prevent this?

A—Close off the discharge valve as much as possible on the pump to be shut down so the rate of flow to be interrupted will be lower.

Q—What is "grooving"?

A—It is a concentration of internal corrosion in a section under considerable stress.

Q—Where would you usually find grooving in a water-tube boiler, and in a firebox boiler?

A—In the water-tube boiler, at the head "flange knuckle," or at the circumferential seams. In the firebox boiler, at the bottom of the furnace sheets near the mud ring.

Q—If you looked at the stack of an oil-burning boiler and saw heavy yellowish smoke emerging, of what would it be a probable sign?

A—That the flame had become extinguished and that the burner was sending unburned oil into a hot firebox—an exceedingly dangerous condition.

Q—If a tube failed in a water-tube boiler in operation, what would you do?

A—Extinguish the fire and try to keep water level from falling below normal without robbing other boilers on line. Close main stop valve if other boilers are on line. If water level went out of sight in the gage glass, have the boiler inspected for damage and replace defective tube. Cause of tube failure should be determined, and if due to an operating condition, the condition should be corrected.

Q—What is meant by headers and stretchers in refractory work?

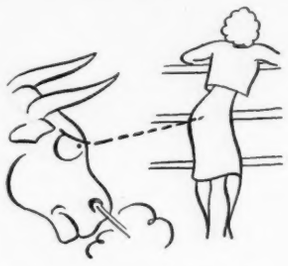
A—Stretchers are courses of brick lying in a flat, horizontal position. Headers are courses lying in a flat, crosswise position, tying two walls together.

Speaking of Power

Somehow the final publication of December POWER, after a year's work on the model hookups, reminded me of the original "cease firing" of November 11, 1918. Maybe there were scenes of wild excitment in all the towns and cities of Europe and America, but it wasn't that way at our regimental headquarters on the French front between St. Mihiel and Verdun. . . . When I got back to H.Q., shortly after the hour that ended the war that "ended all wars", I found the Colonel making an ash tray out of a German field telephone. If I remember correctly, I spent the afternoon hammering a 2-franc piece into a ring. Other artillery officers were engaged in similar useful occupations. . . . Which seems to prove that some of us are busy not merely because something needs to be done, but because it's the nature of the beast. Work becomes a habit—bad or otherwise. Editorial fingers have carved so much Catalin and bent so much dural rod for those hookups that it's hard to stop now. . . . At heart some of us are still mechanics, I think, although we work for a living at this editorial job.

Constructing ash tray....

Which reminds me that I started to write an editorial under the title "Hook Up to 1939". After I finished the first draft I threw it in the waste basket as not being worth a page, but the main idea may rate a paragraph, so here goes: . . . The smart engineer picks his power hookup to meet his actual plant situation most effectively. Why not do the same with the personal hookup? . . .

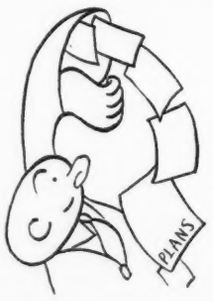


Decision precedes action..

All signs point to a period of steadily improving business, also rising costs and prices, and ultimately slower deliveries of equipment. Therefore, if the plant needs any major face lifting, the operation should be performed as soon as possible to avoid dangerous hold ups, conserve investment dollars and insure maximum return. . . . But decision must precede action, and study must precede decision. Therefore every power chief faces an immediate duty—to study, decide and act on major problems. To make time for all this he may have to pass along some of his routine responsibilities to subordinates, temporarily at least. . . . That means a new *personal* hookup, a rearranging of his job. If done right, it will mean ultimately a better plant, with better men running it.

Editorial cover.....

Starting with this number, *Power* gets an "editorial" cover—that is, a cover without an advertisement. Naturally we editors like that for it gives us a chance to stand in the "front door" ready to shake hands with the approaching reader—the way the Parson does in a Methodist Church. Specifically, we can do three useful things with an editorial cover: 1—"Dress up" the appearance of the book; 2—Display a live picture centered around something of power importance; 3—List the high spots of the month's articles.



Plans up sleeve.....

You may be interested to learn that the editors are not depending entirely on their own judgment, hunches and prejudices in editing this magazine. Almost every month, for more than three years, we have been sampling reader reaction by mail to find out just which articles and departments are read most and why. Starting last October we began to supplement this with the reports of men who go out in the field for us and find out what readers really think about every article in the issue. . . . Finally, of course, the editors have their own constant contacts with the field through travel and correspondence. . . . All in all, we have learned quite a bit about our product from the consumer angle. This research indicates that we are doing a fairly good job, but we already see how to do it better—and we will.

All of which raises the question "What does Power plan for 1939?" The answer, briefly, is that we plan to continue much along the lines of 1938 but liven everything up with still better articles and illustrations and with more editorial reports directly from the field. We shall retain our present departments—also the special section, which has been so popular (Look for "Fuel and Ash Handling", February). . . . And I may as well admit that we have some very special plans up our sleeve for the second half of the year to meet a growing demand of thousands of power engineers. For *Power* will go on changing bit by bit as long as the world changes. We believe the tool must be ground to fit the job.

Some industrial power men think that slag-tap furnaces are for the big utility plants only. Not so! The St. Croix Paper Company up in Maine had burned a costly long-haul fuel for years. They changed to slag-tap furnace and can now burn much cheaper coal. You know the reason: Highly fusible ash, ordinarily a defect in coal, becomes a virtue when you want to melt the ash and tap it off as slag. See page 90.

Utility readers will be interested in the story of the new Essex top (page 50), now operating at 900 F (designed for 950 F.). That, by the way, is hotter steam than most plants like to handle, but it seemed worth while because the old turbines could take the high-pressure exhaust at 650 F. Essex came at the end of a long string of "tops" in other stations, and its designers profited from the thinking of other engineers.

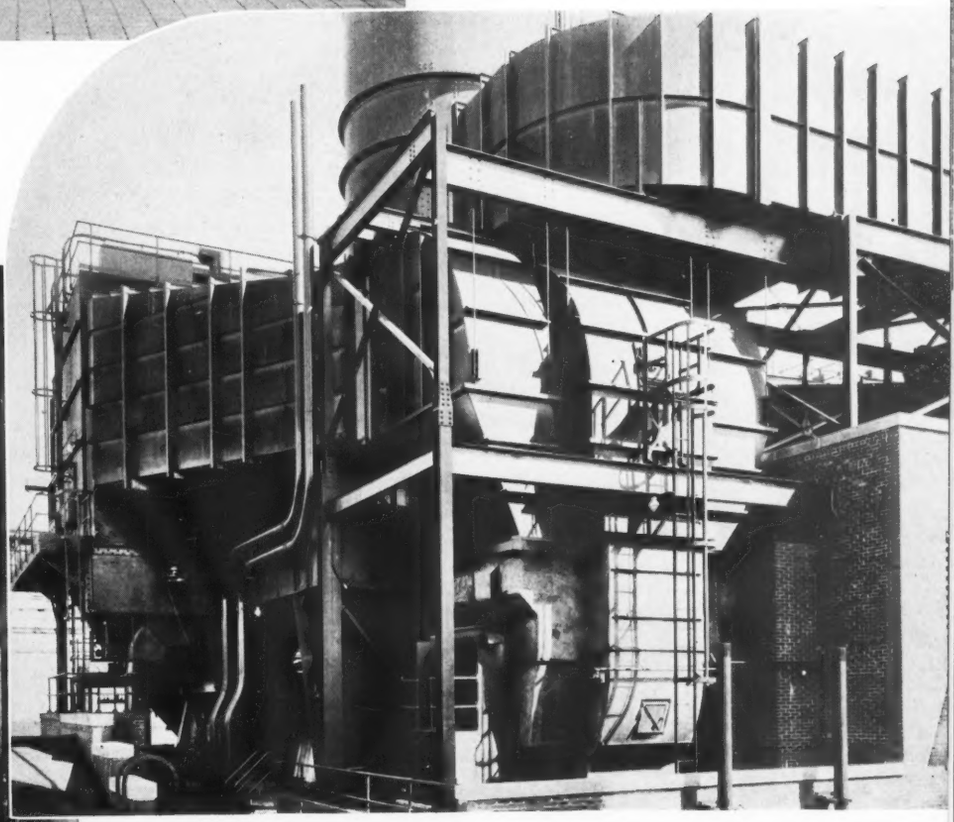
Long string of tops.....

Phil Swain, *Editor*

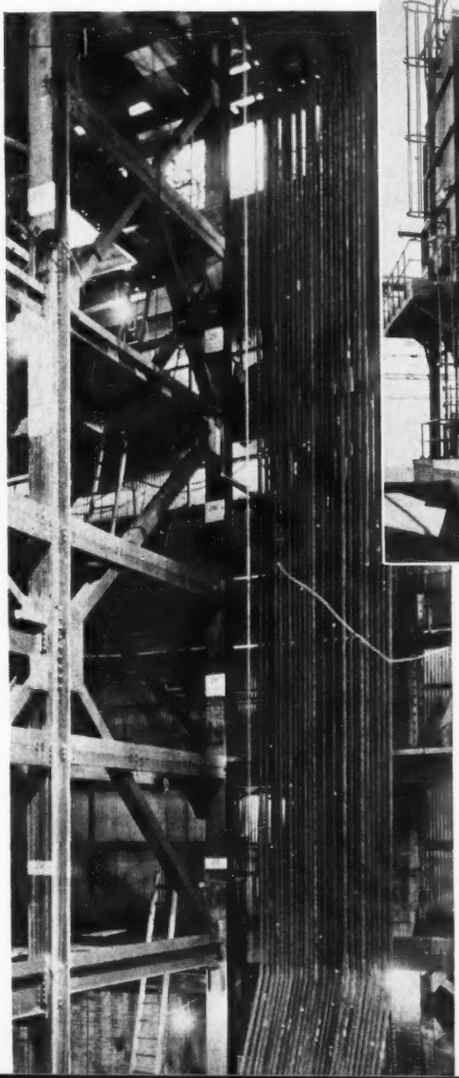
AS MODERN AS 950 f

Additional photos of Essex Generating Station (1250 lb, 950 F) reveal a boiler house up to the minute in every respect

Operating panels, instruments and coal feeders for new high-pressure boilers are at right in photo. Two boilers occupy center of boiler house in space left vacant by removal of six old boilers



Fans, air preheaters and precipitators are above roof line outdoors, but are nearly concealed by coal bunker house and turbine building



80-ft long boiler tubes form rear wall of secondary furnace. Circulation for water walls is supplied by two 20-in. downcomers outside the furnace casing

Pet Milk Company has placed five different orders for Riley "RO" Boilers since August 1936

- August 19, 1936 . . . . Coldwater, Ohio
- December 11, 1936 . . . . Delta, Ohio
- December 11, 1936 . . . . Weyland, Mich.
- April 28, 1938 . . . . Neosho, Mo.
- November 10, 1938 . . . . Neosho, Mo.

You can make bigger savings

Because of the unusually high efficiencies obtained from Riley "RO" Boilers, their installation invariably results in the biggest possible savings.

Efficiencies above 80% are invariably obtained from Jones stoker fired Riley "RO" Boilers. At Seneca Knitting an efficiency of 83.1 was obtained. At Pet Milk Company's Coldwater, Ohio, plant even this high efficiency was bettered — 85.2% being obtained. Such high efficiencies mean tremendous coal saving over ordinary performance and make the Riley "RO" Boiler a most profitable investment.

These efficiencies, to be sure, may seem unusual; however, when you study the design of this remarkable unit, they are readily understandable.

The furnace is water cooled, permitting operation of the stoker equipment at maximum efficiency. You need not baby the stoker to prevent clinker formations. A wide range of coals can be used. The fire can be carried against the side walls. Clinkers will not adhere to water walls.

With the water-cooled side walls and roof, the greatest amount of heating surface is exposed to the heat of the furnace where it does the most effective work. The rapid circulation of water obtained in the boiler, gives efficient transfer of heat of the gases to the boiler water.

And to top off these high efficiency producing factors, an integral economizer is located at the rear of the boiler, greatly reducing flue gas temperatures and further increasing efficiencies.

Pet Milk Company has ordered Riley "RO" Boilers on five different occasions since August 1936. Good proof of the satisfaction and high efficiency obtained from Riley "RO" Boilers.

To be sure of obtaining the greatest possible saving, you should by all means investigate Riley "RO" Boilers when considering new boiler equipment. "RO" Boilers can be fired with oil, gas, all types of stokers and pulverized coal.

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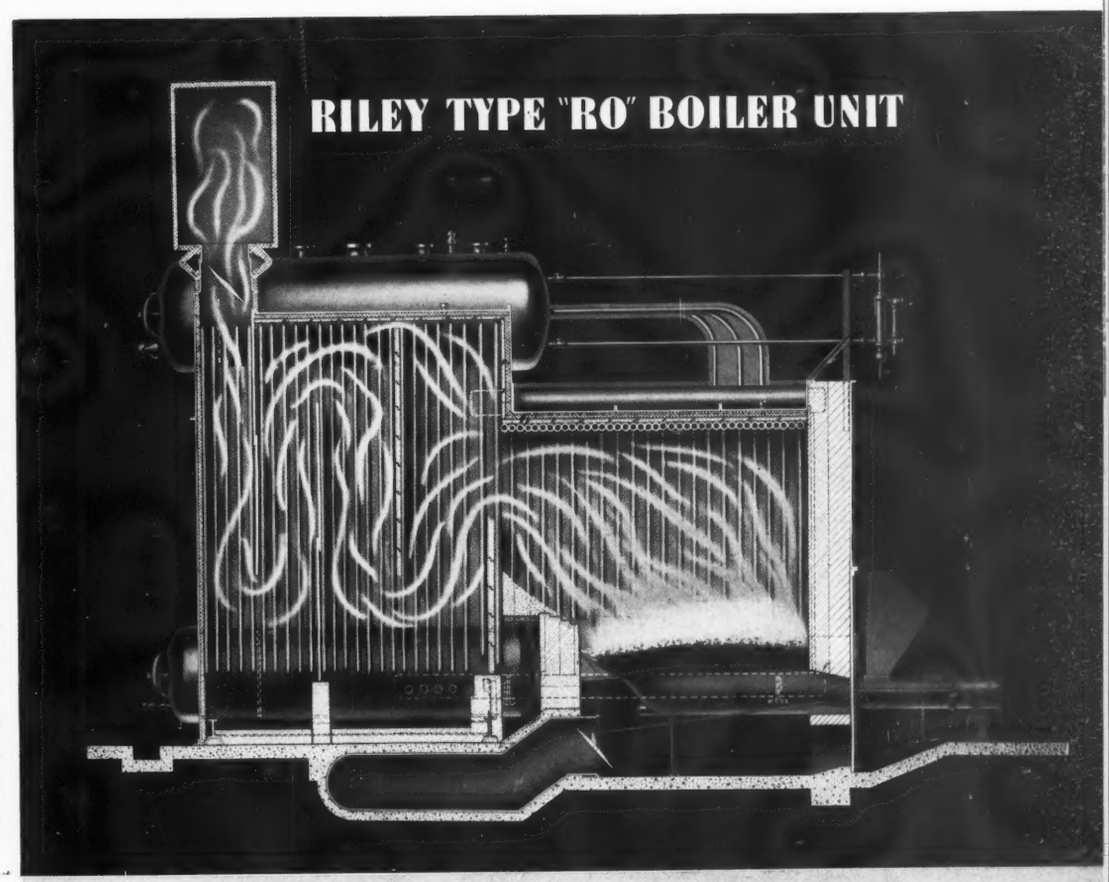
Republic Creosoting Co. . . .	Lima, Ohio
U. S. Gypsum Co. . . .	Plasterco, Va.
Pet Milk Co	Coldwater, Ohio
Pet Milk Co.	Delta, Ohio
Pet Milk Co.	Weyland, Mich.
Pet Milk Co.	Neosho, Mo.
Hercules Powder Co. . .	Carthage, Mo.
Nunn Bush Shoe Co. .	Milwaukee, Wis.
Seeger Refrigerating Co.	St. Paul, Minn.
Bastian Bros.	Rochester, N. Y.
Chestnut Farms Dairy .	Washington, D. C.
Crescent Puritan Laundry	Rochester, N. Y.
Rochester Dairy Co. .	Rochester, Minn.
Worcester Academy . .	Worcester, Mass.
Seneca Knitting Co.	Seneca Falls, N. Y.
Pratt, Read Co. . . .	Ivoryton, Conn.
Hooker Paint & Glass Co. .	Chicago, Ill.
Francis Shimer School .	Mt. Carroll, Ill.
Armour & Co.	Baltimore, Md.



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BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

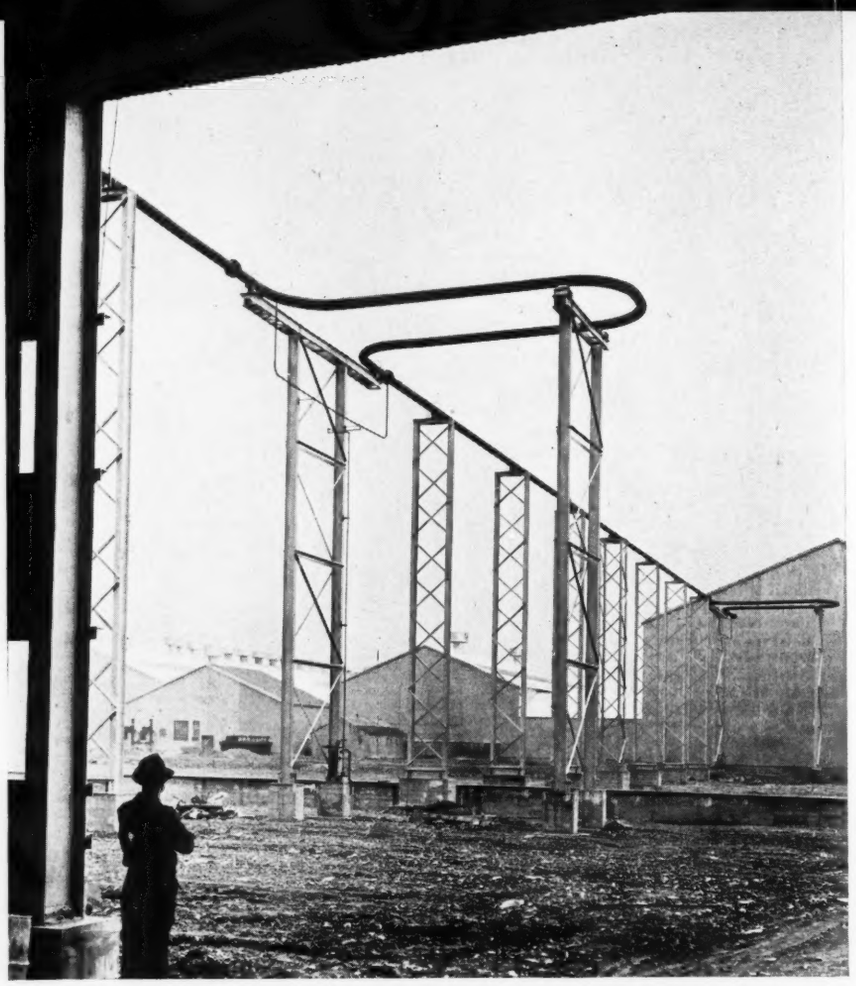


Fig. 1—This 12-in. steam main crosses a 750-ft open court between buildings

Pipe Dream

Sixty miles of pipe, all kinds, all sizes, delivered and erected in nine months. Pre-fabrication, welding, and streamlined erection helped hang up this record at Carnegie-Illinois Steel's new Irvin Works

SIXTY MILES of steel, cast-iron, brass, copper, rubber, rubber-lined and glass pipe, in sizes from 48 in. down to ⅛ in.—delivered, erected and tested in nine months. That's the record hung up by Blaw-Knox's Power Piping Division at the Irvin Works, first "smokeless" steel mill. Streamlined construction methods, everything that modern fabricating and erecting could bring to bear, went into doing this "4-year job" in less than a year.

Irvin Works stands on a man-made plateau 20 miles south of Pittsburgh. From slab to finished strip and sheet, this mill is the last word in steel processing. Powered by electricity brought cross-country from the network connecting Big Steel's Clairton, McKeesport, Duquesne, Braddock and Homestead plants, and fueled with natural and coke-oven gas, also brought cross-country, it is a truly smokeless mill, a mill without a single coal fire. Piping—60 miles of it, carrying gas, steam, water, oil, air, and acids—ties the mile and a half of buildings together.

Sixty Miles of Pipe

What's included in that 60 miles? More than a mile of 12-in. natural-gas pipe snaking across the surrounding hills, for one thing. This main is Dresser-coupling connected in its mile-long underground run. At the mill, it rises 50 ft above ground to run through the buildings, supported on rollers on the roof trusses, and underground between buildings. Coke-oven gas comes in via a 20-in. main to run the same course, supported in the same way. All connections above ground are welded. Gas from these lines supplies more than 150 radiant-tube annealing-furnace bases, the largest installation of the kind in the country, and a battery of slab-heating furnaces.

Furnace stack gas generates steam in waste-heat boilers, and more than two miles of 12- and 10-in. headers feed various parts of the mill for descaling and deoxidizing. Most of the steam mains are roof-truss supported, but about 900 ft of main runs underground in Ricwil duct with glass-wool insulation, and a space of 750 ft between buildings is spanned by a 12-in. line carried 60 ft above ground level on steel towers. Steam piping is welded throughout, and overhead lines are covered with sectional insulation wrapped with a waterproof casing. Square loops, at intervals of about 250 ft, take expansion.

Five compressors, in three stations, supply the mill's air requirement through 8-in. steel mains. Interconnection gives operating flexibility, permits cutting compressors in and out. Air piping is welded, and suspended from building columns.

A large share of the 60 miles of pipe is in lubrication systems, with over 100 tons installed for the lubrication of the hot-strip mill alone. Pipe sizes range from 16 down to ⅛ in.; welded joints insure oil-tightness. Smaller lubricating systems supply the reducing mills and cold mills. Of equal importance to mill operation is the automatic, high pressure grease system. Here welded-steel pipe carries grease under pressures as high as 1800 lb.

Water for cooling comes from the Monongahela River. Three pumps, with a total capacity of 27,000 gpm lift water 400 ft to a reservoir at the top of a hill overlooking the plant. Supply to the mill is by gravity through a 42-in. welded line, running at right angles to the mill's length,

which branches into smaller lines running toward the ends of the mill. Pipe sizes in the mill headers range from 36- to 18-in. Paralleling these lines are similar, smaller lines for filtered water. Both raw- and filtered-water piping is welded and runs underground. Water for drinking comes from the city of Clairton in an 8-in. underground main. In the mill, drinking-water lines run overhead and are insulated against both heat and cold.

Special materials and construction feature the systems handling palm oil and acids. Palm oil, used in the manufacture of tin plate, is stored in a central 50,000-gal. tank. To maintain proper viscosity for smooth flow, small steam lines parallel the oil lines; both lines are wrapped together with insulation. A unique palm-oil-recovery system is installed at this mill. Acids used in treating the oil are hard on piping materials, so rubber pipe and fittings, copper pipe, and glass pipe are used as conditions warrant.

Rubber pipe and fittings carry acids, for pickling, from storage tanks to treating equipment. A complete acid sewage system, made up of 12-in. rubber-lined pipe, run underground, carries waste acid to a neutralizing plant before disposal. Joints in this system are made with rubber couplings, vulcanized to the rubber lining which laps over the pipe end.

Other piping systems installed by Blaw-Knox include hydraulic piping for both water and oil, at pressures ranging from 600 to 3500 lb, sanitary piping, and three separate fire-prevention systems (sprinkler, steam smothering, and Foamite).

Welding

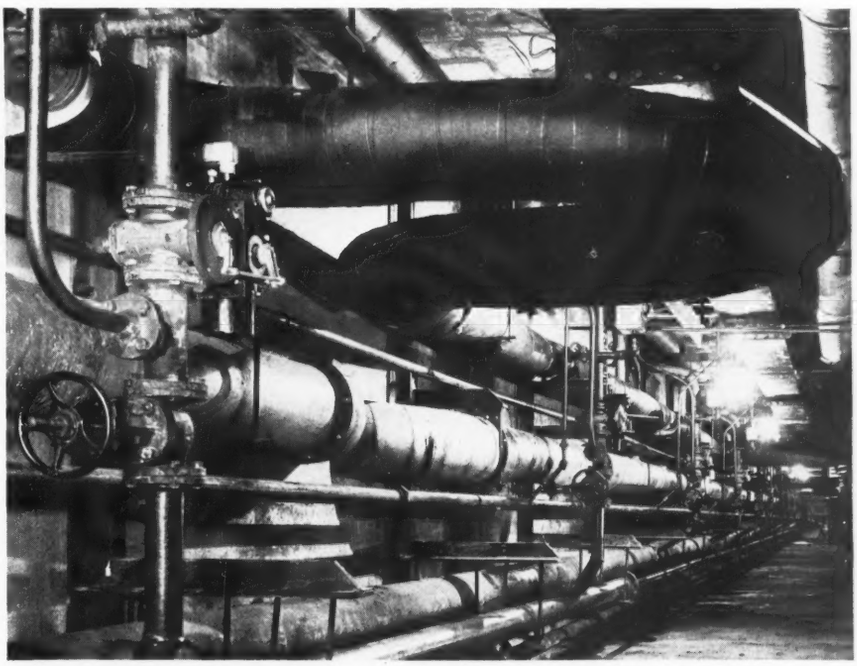
Outstanding general feature of this record-breaking job is the almost total absence of fittings, and the universal use of welding. When the work was at its height, 35 arc-welding sets and 53 acetylene outfits were in continuous use, 24 hours a day. All welders were Hartford certified; all joints, regardless of pipe size or working pressure, have met the same high standards.

Wherever physically possible, bends were used (down to a radius of 3 pipe diameters); this reduced erection time and improved flow conditions. In the interests of economy and speed, most fabrication was handled in shops, with a minimum of field cutting and welding. An interesting example of this is in the use of integral reducers, spun on the pipe end, necking it down to the desired reduced size. This method means one weld at a pipe reduction instead of the two needed if a reducing fitting were used.

Streamlined Construction

Examples of streamlined construction methods are many; most interesting perhaps, is the handling of the long runs of pipe carried on the building roof trusses. All welds in each run were made at a substantial platform erected at one end of the building. A crane with a long boom lifted the 40-ft lengths into place and held them for welding. As each weld was completed, the line was pushed forward, the process being repeated as length after length was added. Pipe was large enough to avoid sagging between trusses (25 ft); a cone-shaped head on the pipe end facilitated sliding the pipe along. Expansion loops were added by cutting the line at the desired point, and pushing it back far enough to insert the loop. The speed of this method is shown by the erection of 2800 ft of 20-in. gas line in 30 hours with a 5-man crew.

Use of more than $140,000 of construction equipment ranging from pipe wrenches to two 4-ton cranes with 50-ft booms accounts for much of the time saved in erection. In spite of speed, the job was completed with a minimum of waste due to careful fabrication and field savings such as making Van Stone connectors from short lengths.



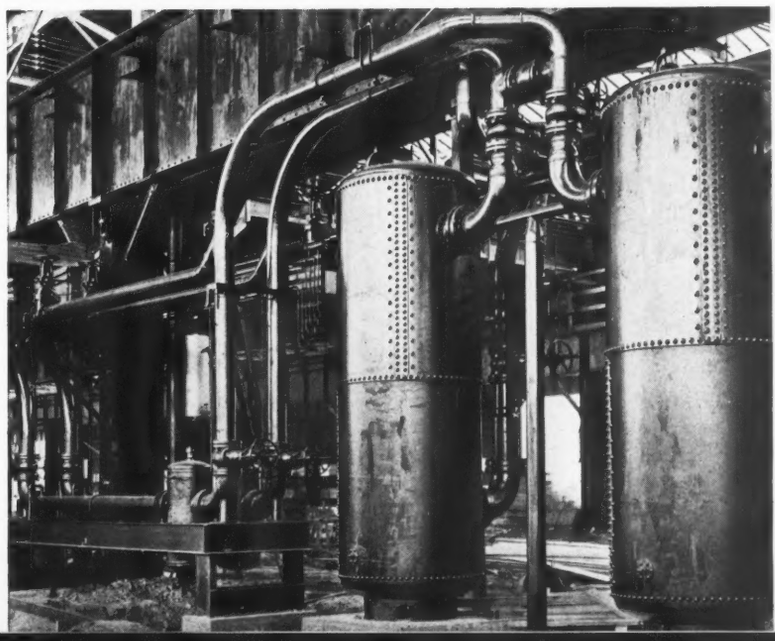
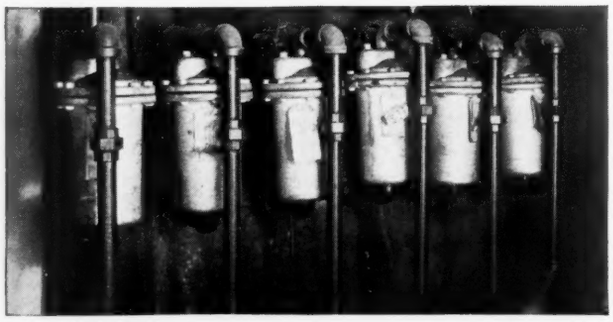


Fig. 2 (above)—There are 28 different pipelines in this tunnel under the tin mill; they carry steam, water, oil, acid, soda and air

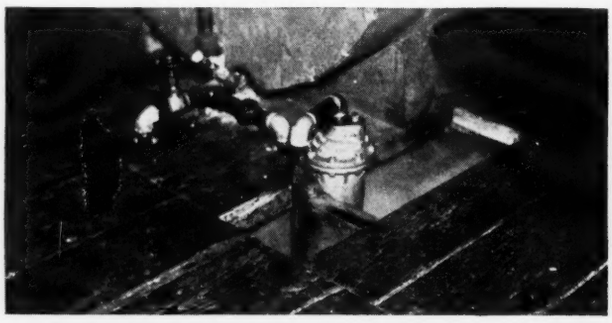
Fig. 3—Piping at compressed-air coolers and receivers

HOW TO MAKE

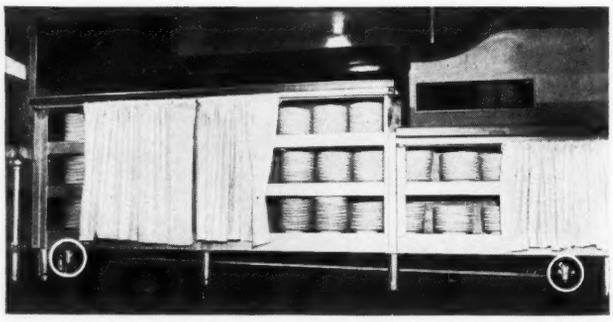


HIGH SCHOOL When Mr. Charles Pillars became chief engineer at City High School in Springfield, Ohio, he found it taking 8 to 9 tons of coal per day. By the time he got through putting in Armstrong traps, the coal consumption was down to a maximum of 4 tons per day—a saving of 50%!

GREENHOUSE Mr. H. B. Henley of Terre Haute, Indiana, changed over to Armstrong Unit Trapping for his greenhouse heating system and he kept records. He writes: "During the winter of 1937-38, we used 211 tons less coal than in 1936-37, with weather temperatures comparable."



SALMON CANNERY The floating cannery S. S. Memnon operating out of Astoria, Oregon, is said to have the world's largest canning retorts. The owners write: "There is little question in our minds but what the traps (on retorts) returned their purchase price several times in fuel saved."



HOTEL Mr. J. H. Harkless, Jr., Assistant Manager of the President Hotel in Kansas City, Mo., decided to do something about the cost of purchased steam last year. He put individual Armstrong traps on all kitchen, laundry and other equipment in the building. The first month's savings paid for the traps!

Change over to ARMSTRONG

YOUR COAL PILE *last longer*

IN ANY heating job or any piece of steam heated equipment under your supervision, you want "BEST" PERFORMANCE and you also want MAXIMUM ECONOMY. In considering means for getting better performance, you may be tempted to sacrifice a little economy.

DON'T MAKE THAT SACRIFICE!

It is unnecessary. Performance invariably depends on how fast and completely you remove condensate and air from any steam heated unit and this in turn depends on two things:

1. Use of individual traps. (This protects you against the possibility of short-circuiting, water-logging, and air-binding.)

2. The size of the valve orifice in any trap you put in.

Observing these two points will give you the key to "maximum performance" but will not guarantee you maximum economy. There is an obvious third requirement:

3. The trap must have a valve that actually closes tight and prevents the loss of any steam even when the steam heated equipment drops from "full load" to "light load" or "no load."

Now check Armstrong against the three points: (1) Armstrong has pioneered "unit trapping," (2) In the Armstrong line you can pick a trap with as big a valve as you want and (3) All Armstrong traps close tight against steam and open wide for condensate and air.

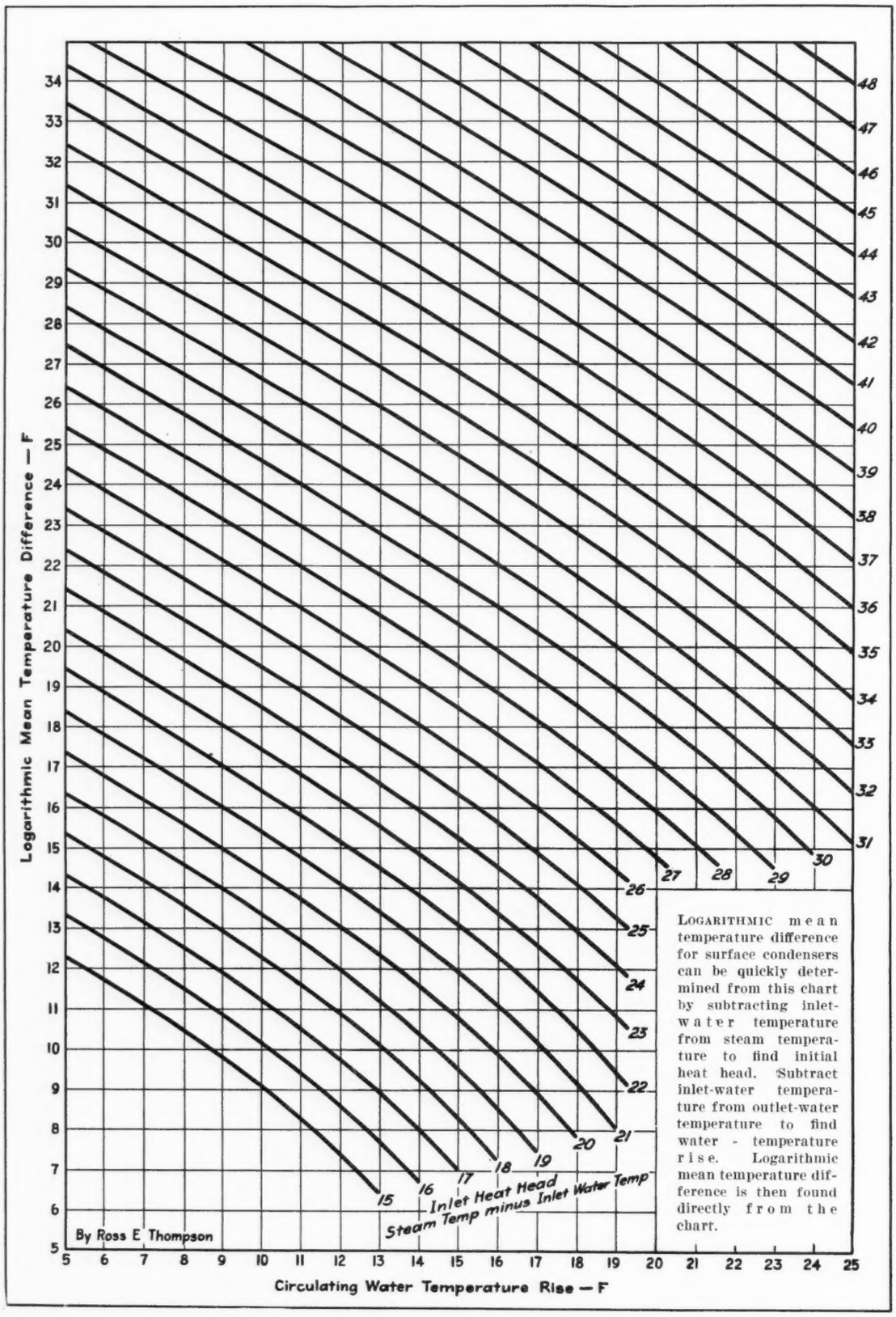
IF YOU WANT "BEST PERFORMANCE," ARMSTRONG CAN GIVE IT TO YOU!

ARMSTRONG MACHINE WORKS
812 Maple St., Three Rivers, Mich.

UNIT TRAPPING

Number 77

Condenser Log MTD


Logarithmic Mean Temperature Difference — F
Circulating Water Temperature Rise — F
Inlet Heat Head
Steam Temp minus Inlet Water Temp
By Ross E Thompson
LOGARITHMIC mean temperature difference for surface condensers can be quickly determined from this chart by subtracting inlet-water temperature from steam temperature to find initial heat head. Subtract inlet-water temperature from outlet-water temperature to find water - temperature rise. Logarithmic mean temperature difference is then found directly from the chart.

© POWER

Keeping Tabs on Condensers

By ROSS E THOMPSON
Mechanical Engineer, Albuquerque Gas and Electric Co

A daily check on condenser heat transfer rate involves only a few temperature readings, simple calculations. This article tells you when it pays to clean

WHEN vacuum falls an inch or so, and exhaust-steam temperature jumps 20 deg, most any turbine operator will get an inkling that something is wrong with the condenser. But the more usual case is a gradual change from day to day and it takes more than a squint at the vacuum gage to tell when it pays to plug, scrape or do whatever else passes for tube cleaning in your plant.

The form shown on this page, together with Data Sheet No. 77 on the page opposite, allows a ready and almost automatic check from day to day regardless of varying loads and water temperature. The record form can provide space for any convenient number of readings, and, if made on tracing paper, as many copies can be made as desired by blue-line printing. A separate form should be made for each condenser.

Readings *A* to *G* can be taken from usual station instruments. Item *H*, mean temperature difference, should be based on the logarithmic formula:

$$H = MTD = \frac{T_2 - T_1}{\log_e \frac{T_s - T_1}{T_s - T_2}} = \frac{F - G}{\log_e \frac{E - G}{E - F}}$$

which is plotted as a chart on the opposite page for the temperature range usually encountered in steam-turbine operation. This chart saves most of the work of calculation, it being only necessary to know the difference between temperature of steam and inlet water, and the water-temperature rise.

The constant used in line *J* of the form should be carefully determined by calculating from test data or manufacturer's guarantee. Once determined, it remains constant for a given machine and may be printed on the form for use indefinitely thereafter. This calculation is not difficult and is best done by comparing the steam consumption of the turbine at some definite load and 90 F with that for, say 100 F. Or, the difference may be calculated for a ½ in. difference in vacuum and the result converted to steam temperature by referring to the saturated-steam tables.

Condensers not favored with scale-free and slime-free water require occasional or frequent cleaning. The form, when completed, tells in simple figures just how long it pays to go on operating without cleaning, and how much extra it costs to clean more or less often to suit operating convenience.

Air leakage, another possible source of poor vacuum, can be checked easily, without air-flow meters or calculations, by shutting the air line from condenser to air pump off tight and seeing what happens. If the condenser is reasonably tight, vacuum will not fall off more than an inch in ten minutes. In one case, vacuum fell off only about one-half inch in fifteen minutes.

Treating circulating water to prevent slime formation or even scale formation, particularly in closed systems with spray pond or cooling tower, sometimes pays handsome dividends. The form here presented allows comparison of the total cost per day (item V) when calculated for both chemical treatment and mechanical cleaning.

CONDENSER DAILY CHECK

(Readings at 7, 8 and 9 PM Each Day)

ALBUQUERQUE PLANT

9000-Sq-Ft WESTINGHOUSE CONDENSER NO. 5

DATE NOVEMBER 1938	1	2	3	4
(A) KW LOAD	4,400	4,300	4,700	
(B) TURBINE STEAM RATE AT THIS LOAD				
(C) STEAM CONDENSED PER HOUR, LBS	63,000	61,000	67,500	
(D) CONDENSATE TEMPERATURE °F				
(E) EXHAUST STEAM TEMPERATURE	87	90	81	
(F) COOLING WATER OUTLET TEMPERATURE	77	81	71	
(G) COOLING WATER INLET TEMPERATURE	66	70	59	
WATER TEMPERATURE RISE (F-G)	11	11	12	
INLET HEAT HEAD (E-G)	21	20	22	
(H) MEAN TEMP DIFF	14.8	13.8	15.2	
(I) TEMP DIFF SHOULD BE WHEN CLEAN	13.3	12.2	13.6	
(J) LOSS IN TURBINE EFFICIENCY, PERCENT = .56 (H-I)	.54	.575	.575	
(K) INLET WATER PRESSURE, LBS				
(L) OUTLET WATER PRESSURE, LBS				
(M) LBS DROP THROUGH CONDENSER				
(N) GPM (CALCULATED) (C x 1.9) ÷ (F-G)				
(O) TOTAL STEAM PER DAY TO THIS TURBINE	1,000,000			
(P) EXCESS STEAM DUE TO ABOVE	5,400	5,750	5,750	
(Q) STEAM COST PER THOUSAND POUNDS 25¢				
(R) EXCESS STEAM COST FOR ONE DAY $	1.35	1.44	1.44	
(S) DATE LAST CLEANED 10/20/38				
(T) NUMBER OF DAYS SINCE LAST CLEANING	10	11	12	
(U) COST OF CLEANING $ 60.00 DIVIDED BY DAYS SINCE CLEANING	6.00	5.45	5.00	
(V) TOTAL COST PER DAY (R PLUS U)	7.35	6.89	6.44	

When total cost per day (V) reaches a minimum and starts to increase, condenser should be cleaned. Logarithmic mean temperature difference (H) is determined from chart on facing page

Slag-Tap Saves at St. Croix

To burn the most economical coal, St. Croix Paper Co, Woodland, Me., changed its high-pressure-boiler furnace from dry-bottom to slag-tap and developed methods for tapping the furnace that reveal much engineering ingenuity

By JOHN T TOPALOSKY
Steam Engineer, St. Croix Paper Co

FREEDOM in choice of fuel is a factor frequently overlooked in boiler-plant design. Particularly is this true of plants long distances away from a coal supply. Under such conditions, a high-grade coal is the most economical, because of high freight charges. These were the conditions that we operated under for many years until recently, when a nearby supply of lower-grade coal became available at attractive prices.

Our large pulverized-coal-fired boiler has a maximum continuous rating of 125,000 lb of steam per hour at 450 lb and a total temperature of 725 F. This boiler was set in a furnace with side and rear walls water cooled and had an air-cooled dry bottom. Coal burned contained 0.7% sulphur and 4% ash that had a fusing temperature of 2400 F and became fluid at 2675 F. The new coal contained 3.79% sulphur and 15.5% ash that fused at less than 2000 F and became fluid at 2300 F.

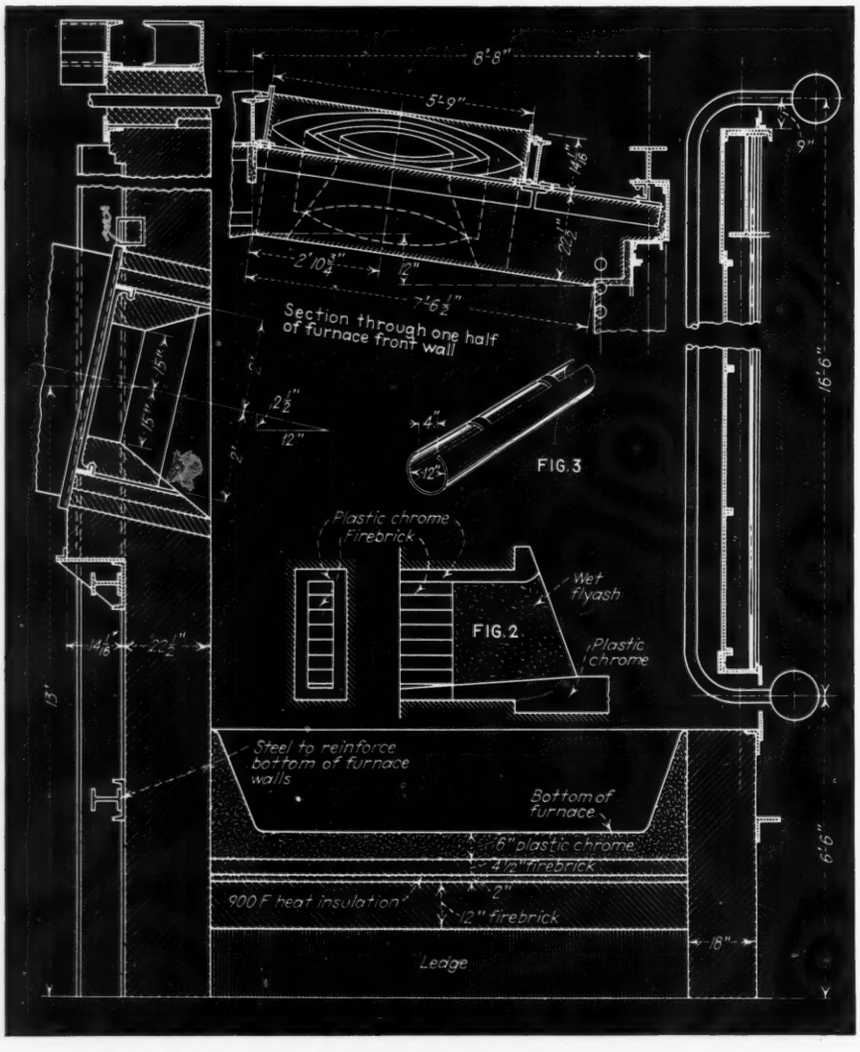


Fig. 1—Cross section of furnace after being changed to slag-tap operation. Fig. 2—Slag-tap hole plugged with firebrick and wet flyash. Fig. 3—Quenched slag chute made of iron pipe with 4-in. slot cut in top

Burners and Refractories

After some experimenting with this coal in pulverized form under one of our 100-lb boilers, it was decided, because of the low fusing temperature of its ash, that it could be burned successfully under the large boiler in a slag-tap furnace, using rotary-type burners. The old burners were set with axis horizontal and at right angles to the front wall. Our experiments indicated that the axis of two new burners should point inward and downward, as indicated in Fig. 1. The furnace front was reconstructed accordingly.

Because of the sulphur and iron in the coal, considerable experimenting with refractories had to be done before satisfactory ones were found for lining the furnace. A chrome-magnesite brick, containing a small amount of dead burnt magnesite, was found to be most satisfactory. This brick has a fusing temperature of about 2900 F in the presence of our slag, and 3100 F in air. Plastic chrome was used whenever a plastic refractory was required.

To insure a sufficiently high slag temperature, burners were arranged to rotate the flame inward, rather than outward. In this way the flame is directed downward over the center of the slag pool and then outward and upward along the furnace sidewalls.

Furnace Rebuilt

The bottom of the furnace was completely rebuilt as in Fig. 1, with the slag-tap hole directly below the center line between the two burners (see Fig. 4). The slag pool was lined with 6 in. of plastic chrome. Below this lining is 4.5 in. of high-temperature

chrome-magnesite firebrick, under which is 2 in. of 800-F heat insulation and below this, 12 in. of ordinary firebrick. The furnace bottom was given a slope of 0.5 in. in 3 ft from all directions toward the slag-tap hole.

Tapping the slag is one of the important problems in operating a slag-tap furnace. We installed a slag-tap hole in the slag pool and developed a method of tapping that is simple, inexpensive and gives complete control of the slag at all times when tapping. The hole is one fire-brick-width wide and is lined with 2 in. of plastic chrome. It is 16 in. high on the inside with its bottom sloping down to give a height of 20 in. on the outside. On the inside, the hole is sealed with wet flyash and on the outside with firebrick laid flat. These bricks are driven in against the wet flyash until they are flush with the furnace wall, as in Fig. 2, and sealed with wet flyash.

Making a Slag Spout

A spout for carrying the quenched slag from the furnace was made from sections of 12-in. second-hand pipe, with a 4-in. slot cut along the top side of each section with a cutting torch, Fig. 3. These sections were laid in place and welded together. Three sluicing nozzles were placed across the diameter of the spout just below the slag-tap hole. Two side nozzles are 1 in. in diameter and point slightly toward the center nozzle, which is 2 in. in diameter. These give a water flow of about 300 gpm under 40-lb pressure. A secondary 1-in. water line is brought into the spout about 10 ft from the tap hole.

During the normal operation, slag is tapped off every 24 hours at 8:00 a.m., but the slag level is never allowed to come above the top of the tap hole. If this level is reached in less than 24 hours, as may occur when the boiler operates under high ratings for long periods, the furnace is tapped. This job is done by three men and requires about one hour. Two men could easily do the work, but a third man insures maximum safety.

Tapping Procedure

To tap the furnace, after the water jets are flowing, the top brick is removed from the tap hole and the flyash dug out of the top of the hole to start the slag flowing. After this, it is only a matter of keeping the slag flowing, as its level recedes, by digging out the flyash down to the level of the second brick. When this condition is reached, the second brick is lifted into the top of the hole and flyash dug out to keep the slag flowing.

When the level of the third brick has been reached, it is lifted into the original position of the second brick and held there for a short time until it seals in place with slag. Then, the flyash is dug out as before. Any cracks around the brick in the top of the hole are sealed with wet flyash. This process is followed until the slag has drawn down to about 1- to 3-in. depth over the bottom. At no time is the slag hole larger than one brick, so that air leakage into the furnace to cool the slag is negligible.

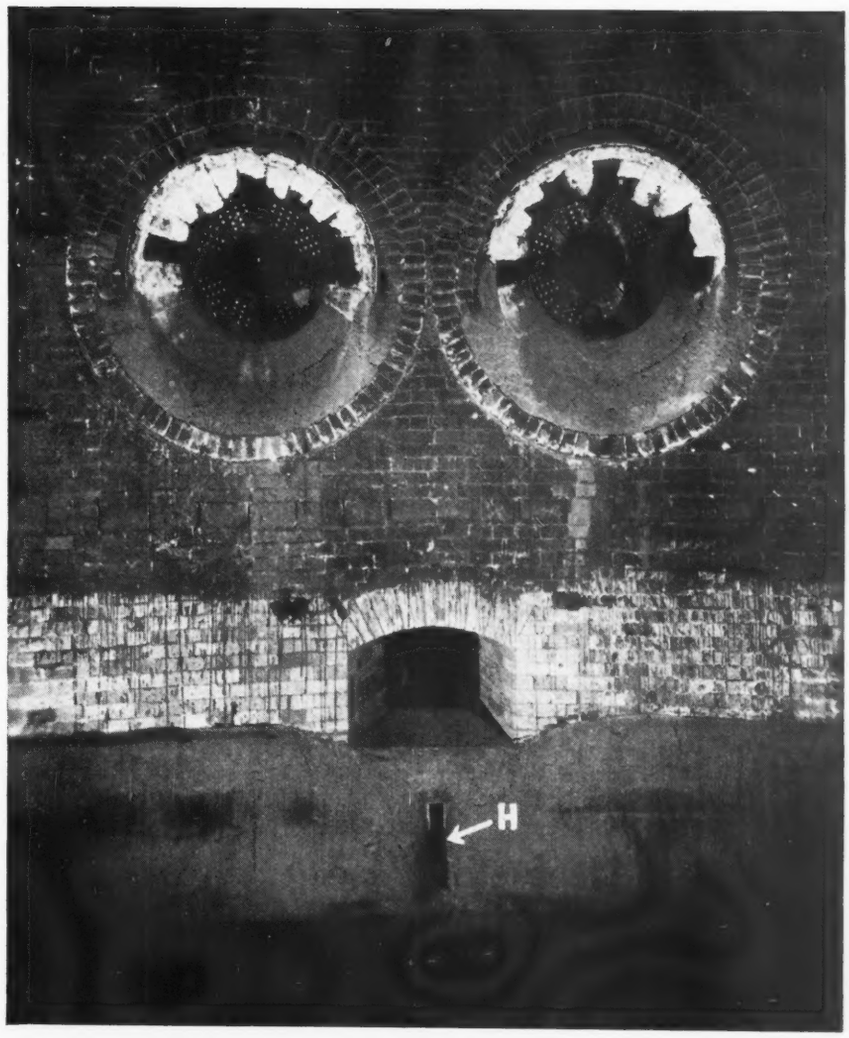


Fig. 4—Inside the furnace—note slag-tap hole (below at *H*) and two burners above

When burning the new coal, we can slag-tap when the boiler is operating at as low as 40% of normal rating. At 75% of rating the slag pool has a temperature of between 2600 and 2700 F and we have no difficulty in slag tapping when burning the high-quality coal, ashes of which are fluid around this temperature.

We always leave about 1 to 3 in. of slag in the bottom of the furnace, even when drawing off the slag before shutting down the boiler. This is done so that the flame will not play directly upon the furnace-bottom refractories. Slag solidifies when the boiler is out of service and when it is started again, slag expands and tends to push out the side walls of the furnace. To prevent this, heavy steel reinforcing has been placed around outside the furnace wall at a level just above the furnace bottom as shown on the right in Fig. 1. This reinforcing holds the furnace walls in place, even when the stresses in the solid slag are sufficient to cause it to buckle upward away from the furnace bottom.

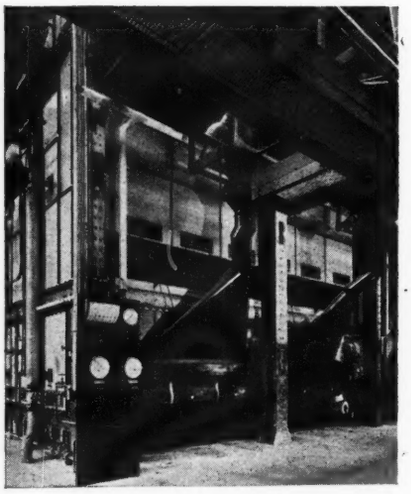
Experience Satisfactory

We have now had over one and a half year's experience in operating the slag-tap furnace and feel that our problem has been satisfactorily solved. We can now burn any coal that we find most economical. Excess air in the furnace has been reduced to give an average CO_2 of 15.5%. Because of the higher temperature that we can maintain in the furnace, boiler and furnace efficiency has been improved about 2%. Our economizer and air heater have sufficient heat-absorbing surface to maintain stack temperature as low as it is safe to operate, without getting into corrosion trouble because of condensation.

Old Boiler Plant Goes Modern

Three new boilers and world's largest installation of spreader stokers bring 30-year-old plant up to date at Sears, Roebuck & Co, Chicago, Illinois

By CHAPIN ROBERTS
Supervising Mechanical Engineer, Construction Dept



One of new 11,650-sq-ft boilers with 6-zone spreader stokers

WITHOUT INTERRUPTING vital power services, eight old boilers were replaced by three modern units and the world's largest installation of forced-draft spreader stokers was made at Sears, Roebuck & Co in Chicago. For more than 30 years this plant had met the steam and power requirements of "mail-order headquarters," supplying the administration building, retail store, and central distributing plant, covering about 4 square blocks at Homan and Arthington streets, Chicago. Early in 1935, however, need for more steam-generating capacity and a desire for higher operating efficiency led to a decision to rebuild the boiler plant.

Old equipment consisted of twelve 500-sq-ft long-drum, straight-tube boilers, equipped with natural-draft chain-grate stokers. Eight units were more than 30 years old and it was evidently not advisable to spend money to recondition them and install new fuel-burning equipment. The remaining four boilers were in condition to give another ten years of satisfactory service, so the selection of combustion equipment for their modernization became the logical first step in the program. Since there was no immediate emergency, the program could be carefully planned and proper thought could be given to replacement of equipment.

Distance from boiler-room floor to front headers of the old boilers was 7 and 9 ft, in accordance with practice prevailing some 30 years ago. Dutch ovens projecting 7 ft in front of the units housed the chain grates. Bridgewalls were built out over the rear end of the grates to the front line of a water back. Furnace volume was exceedingly limited.

The boiler house was originally designed to receive twelve 5000-sq-ft boilers in 6 batteries of two boilers each, and the center wall of each battery setting as well as the two outside walls was supported on a heavy steel-plate box-girder, with its top just below the floor. These girders served to support the boilers and the boiler-room floor, and tied the whole building structure together. In the basement below, a continuous bucket conveyor ran in front of the old ash hoppers, extended up at each end of the boiler house, and horizontally over the top of the coal bunker. The bunker extended the length of the boiler room with gravity spouts for delivery of coal to stoker hoppers. Ash and coal were handled by the same conveyor.

Selecting the Stoker

After several months study during which every available type of stoker was considered and existing installations investigated, it was decided to install one test unit, a spreader stoker manufactured by the Hoffman Combustion Engrg Co. This unit had a 10x8 ft 5 in. grate arranged in three dumping zones across the width and equipped with three coal-feeding machines. The low setting limited furnace volume to 623 cu ft. The front wall of the old brick setting was replaced with all new material, the Dutch-oven effect removed, the bridgewall remodeled and furnace sidewalls repaired.

Where previously it had been possible to develop only slightly more than normal rating, the new stoker could easily develop 225% rating, but the heat released in the limited volume was sufficient to soften refractories, if this rating was maintained. It was found that operation at 175% could be maintained continuously without more than ordinary refractory depreciation.

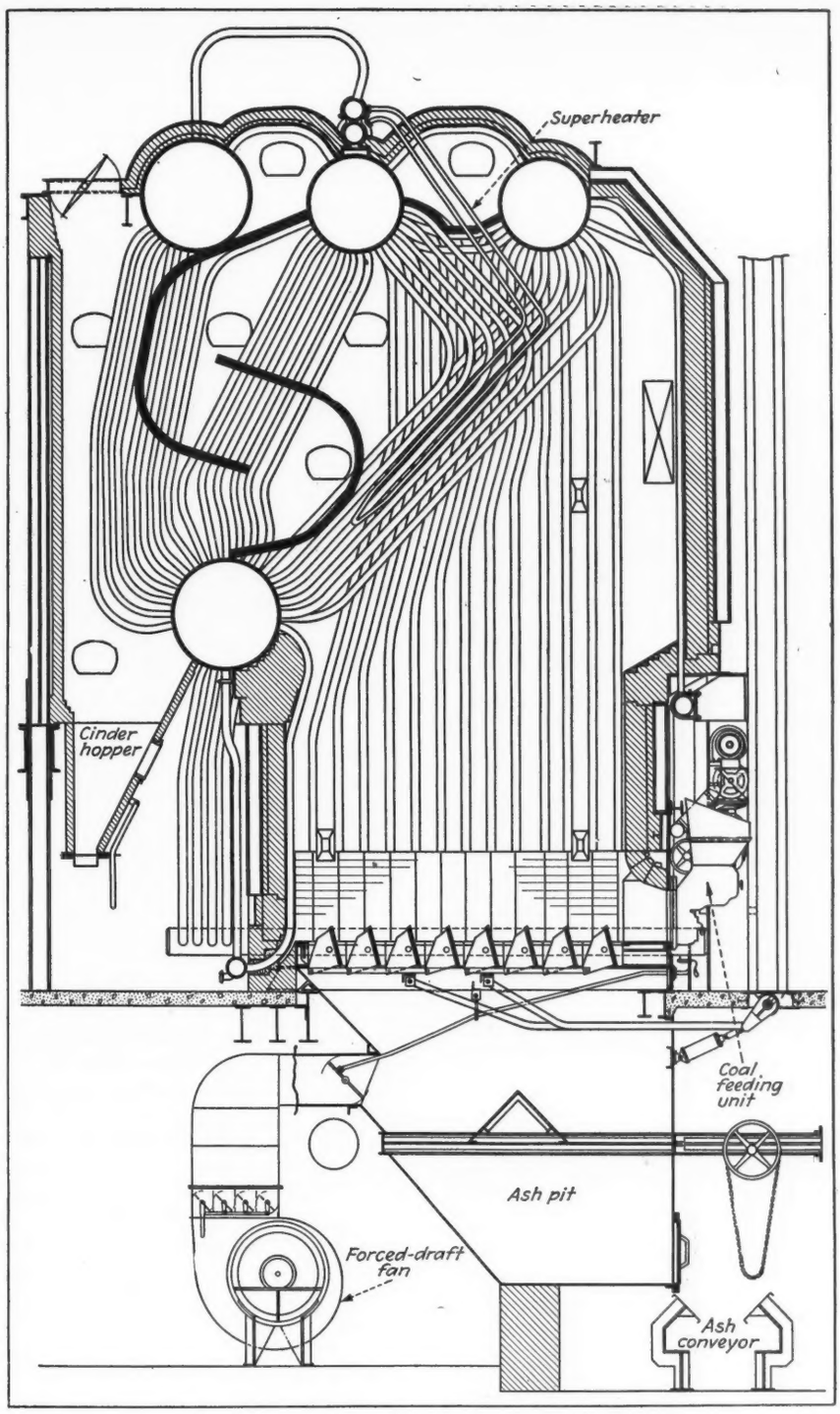
Using the same coal as before, tests showed that the cost of fuel to produce 1000 lb of steam was approximately 25% less than before, even though operating at higher rating. Exit-gas temperatures were approximately 80 F less than before at like ratings. Performance of this first unit was carefully watched for almost two years to be sure this could be depended on, and during this time there was absolutely no expenditure for stoker maintenance. Performance was satisfactory in every way and met manufacturer's guarantees in the many boiler tests made.

Purchase of three more stokers in the fall of 1935 followed this long period of test and observation. Like the first unit in all major respects, increasing depth of grate to 9 ft 9 in. gave much-needed additional furnace volume. Replacement proceeded slowly as each chain-grate stoker had to come out before a new stoker could be installed.

The Larger Units

Satisfactory performance of spreader stokers under the 5000-sq-ft boilers indicated their suitability for the larger boilers, and it was found that these stokers could be installed with less change to existing building conditions than would be the case with any other type. Space limitations required the new boilers to be about as deep from front to rear as the 5000-sq-ft units.

It was decided to install a single boiler in the space occupied by a battery of two "5000's," so that sidewalls and supporting columns would be over the heavy girders mentioned before.



Section through new boiler, stoker, and ash pit

The problem of the beam which had supported the center wall of the battery setting was solved by constructing new steel ash hoppers at either side and providing an inverted "V" of steel plate on top of the beam so that ash from the dumping grate would be deflected to one side or the other.

With this arrangement, three new boilers replaced six old ones and the remaining battery was removed to leave space at the end of the boiler room for a shop. New units are 4-drum, bent-tube boilers built by the Lasker Boiler Engrg Co, Chicago. Sidewalls, bridgewalls and upper part of front wall are water-cooled. Boilers can be operated at 200% rating continuously and can be operated at 300% if so desired; rated surface is 11,650 sq ft. Operation is at 175 lb with 75 F superheat, but boilers are designed for 450 lb and 200 lb superheat. Consideration was given to economizers or air preheaters, but for the present, at least, such equipment was omitted.

Each boiler unit in the plant is equipped with Bailey steam-flow airflow meters, illuminated-scale pressure and draft gages, and periscope smoke indicators furnished by T W McNeill Engrg Equip Co. Settings are Reintjes suspended walls, and baffling is as furnished by The Engineer Co.

Stokers for the larger boilers have 6-zoned grates and six coal-feeding machines on a common drive shaft, with a 3-hp Crocker-Wheeler motor at one end and a Pyle-National steam turbine at the opposite end. The turbine end has an overriding clutch so turbine can be started and take over the drive without stopping the stoker. Grates are 23 ft 4 in. wide by 11 ft 1 in. deep, giving an active area of 258 sq ft. This compares with an active area of 68 sq ft on the first stoker installed, and 102 sq ft on the other three under 5000-sq-ft boilers. Ash is dumped periodically to ash pits in the basement, and from these pits goes to the Peck Carrier bucket conveyor.

Draft Equipment

Draft equipment consists of Clarage forced-draft fans direct connected through flexible couplings to Crocker-Wheeler motors; no induced-draft fans were installed. Rear portions of the settings are undercut to the bridgewall and the usual steel suspended hoppers collect fine ash precipitated from the gas stream in the last pass. No special equipment is provided for precipitation in the breeching. A United Conveyor Corp "Nuveyor" system periodically removes ash from rear hoppers, discharging to a receiving bin for disposal. There is not enough carbon in this ash to justify any attempt at recovery.

Coal used at present is ¾-in. washed screenings from an Indiana strip mine. At various times, coals ranging from 1¼-in. screenings down to carbon, or 5/16 in. minus, and from fields in Indiana and Illinois, have been burned.

Guarantee for the 5000-sq-ft units stipulated ability to generate 200% of normal rating, and that at 150 % an over-all efficiency of 74 per cent could be attained with CO_2 of 13%. Corresponding figures for the 11,650-sq-ft boilers are 300%, 200%, 78.5%, 14%. Many boiler tests, conducted according to ASME specifications, were run to ascertain load-carrying performance and efficiency. Coal, water, and ash were weighed, coal and gas samples carefully taken and analyzed, and temperatures recorded. These tests demonstrate that the equipment is capable of meeting all guarantees made by boiler and stoker manufacturers. The entire present load can be carried on the three large units, and in all there is ample reserve capacity to take care of increase in steam demand.

Belt Tension As You Like It

Too much tension is as bad as too little—one solution is the pivoted motor base that will automatically maintain proper tension in flat and multiple V-belts

By J R HOPKINS
Chicago Belting Co

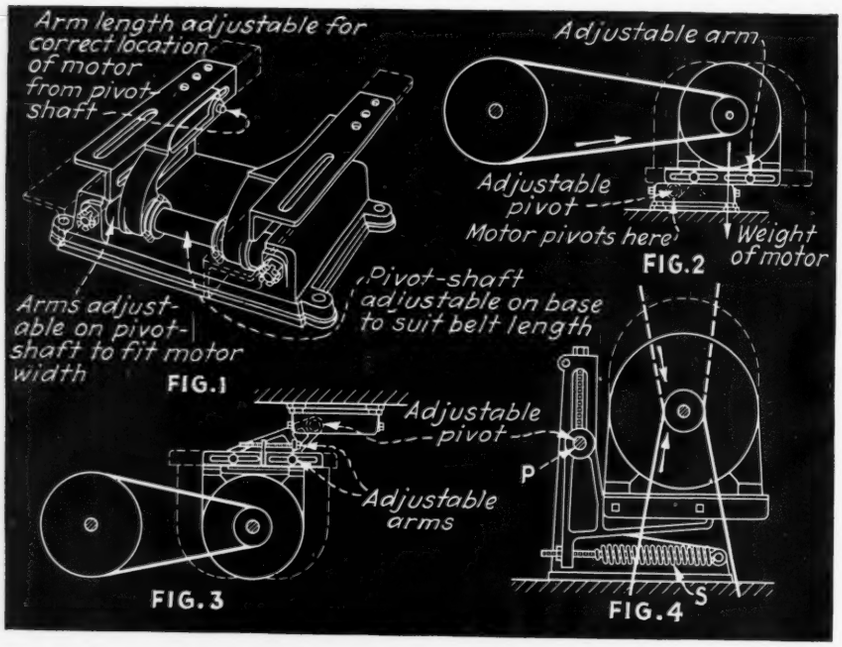


Fig. 1—Pivoted motor base. Fig. 2—Pivoted motor base applied to a horizontal drive. Fig. 3—Pivoted motor base used on a ceiling lineshaft application. Fig. 4—Pivoted motor base for vertical belt drives

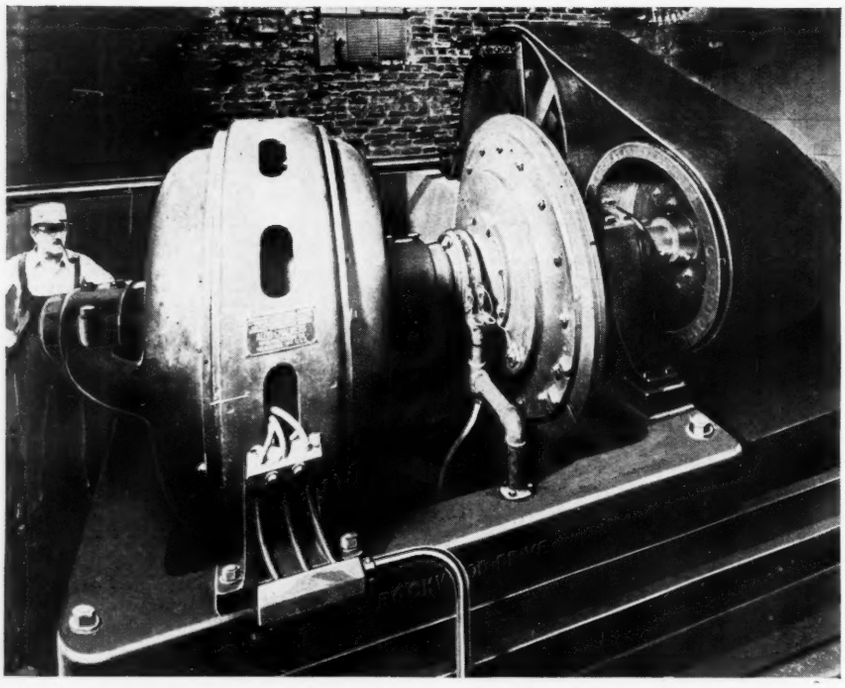


Fig. 5—A 375-hp, 450-rpm synchronous motor on pivoted base drives rolling-mill lineshaft through 34-in., 3-ply leather belt

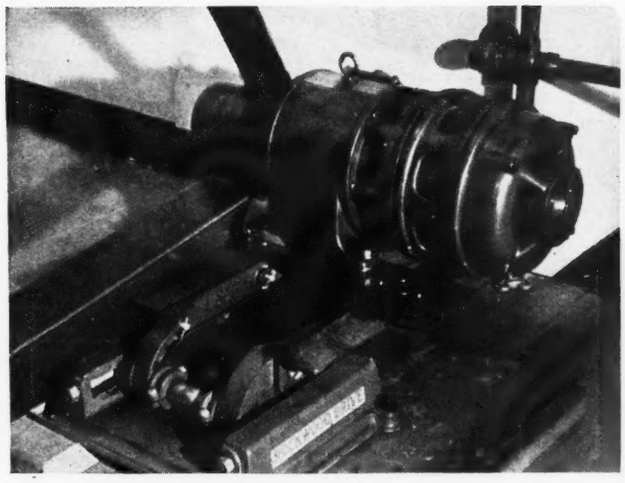
PROPER TENSION in either a flat or multiple V-belt is a controlling factor in satisfactory operation. This is the minimum amount required to drive the maximum load without objectionable slip. Too much tension causes excessive wear on the belt and bearings. Too little tension reduces the power transmitting capacity of the belt and restricts the output of the driven machine.

All belt transmission is friction drive, requiring that the belt and pulley surfaces in contact be held together under pressure by belt tension to produce the necessary friction to drive the load. V-belts obey the same laws governing all friction-belt drives, except that the wedging action of V-belts accounts for part of the pressure required to produce necessary friction instead of having all pressure come as belt tightness, the case with flat belts.

All belts stretch in service; therefore, they require a means for maintaining uniform belt tension so that production-machine speed will be maintained uniform and belt wear reduced. This is what a Rockwood pivoted motor drive does and why it is used extensively with both flat and V-belts. These drives use part of the motor's weight to maintain correct tension in the belts.

Floor Mounting

The standard or floor mounting pivoted-motor base, Fig. 1, has two arms, pivoted on a shaft, which is in turn mounted on adjustable screws running the length of the housing. Thus the entire pivot shaft can be moved forward or back to accommodate an endless belt length by turning the nuts on the two pivot-shaft screws. On the pivoted arms are adjustable arms free to be moved forward or backwards, as shown by the dotted lines. These bases are adjustable for different motor widths so that each one



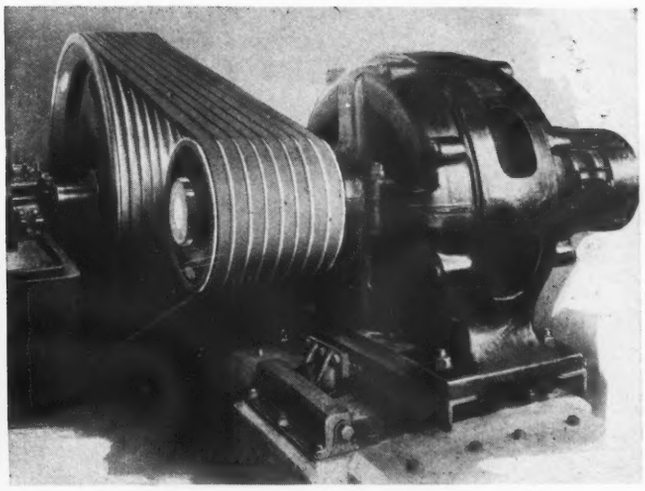


Fig. 6 (top left)—A 3-hp gearmotor on a pivoted base drives through a flat belt on pulleys 5.5 and 108 in. in diameter

Fig. 7 (top right)—A 145-hp, 900-rpm synchronous motor on pivoted base drives shaft by multiple V-belts on 20- and 72-in. sheaves

Fig. 8 (right)—Circular shear driven by 1-hp, 1700-rpm motor on pivoted base and vertical flat belt

can handle a range of frame sizes. This is an important feature, specially when you have to substitute a spare motor for one that has failed, and the two do not have the same dimensions.

The motor is bolted to the adjustable arms and can be moved forward or back, away from or immediately over, the pivot shaft. In this way any part of the motor's weight can be used to maintain belt tension. The driven load determines the amount of belt tension required. If you want a lot of tension you move the motor out away from the driven machine so that it has considerable overhang in relation to the pivot shaft. If you want very little belt tension you move the motor toward the driven shaft until only a small part of its weight is used for belt tension, as indicated in Fig. 2. It is exactly like moving the weight on the beam of a scale, and just as accurate. With every movement of the motor on the arms to adjust tension in the belt, there must be a corresponding and opposite movement of the adjustable pivot to maintain the distance between shaft enters practically constant, and the motor base horizontal, as in Fig. 2.

Tension Adjustment

After these drives are installed, belt tension is adjusted to load requirements by trying the motor in different positions, until one is found where minimum belt tension required to handle the maximum load without belt slip is obtained. As the belt stretches, the motor falls just enough to take up the belt stretch and automatically keep its original tension. Once the correct tension is established at time of installing the drive, future adjustment is generally not required.

If the tension is adjusted to the minimum required to drive the maximum load, bearing pressures are less than with fixed center drives. This results in reduced bearing wear, improved lubrication, elimination of burned out bearings because of tight belts, reduction in power consumption and increased belt life.

On fairly long-center drives or with short-center drives using inferior grades of belts, the stretch may be sufficient to permit the motor to take a position where its base inclines below the horizontal. When this condition is reached the pivot shaft should be moved back until the motor's base is brought back to the horizontal.

Where possible, run the drive so that the tight side of the belt is near to the pivot shaft, as in Fig. 2, rather than away from it. With tight side of the belt near the pivot shaft the reaction of the motor under load automatically helps to keep the belt tight. Consequently, the motor does not have to be placed as far out on the arms as when tight side of the belt is away from the pivot.

Pivoted bases are also made for ceiling mounting, Fig. 3, and for vertical belts, Fig. 4. They are also made in a special type for industrial internal-combustion engines, heavy-duty oil-field-pump drives and for textile machinery requirements.

Frequently ceiling drives constitute a trouble zone for plant maintenance men. Belts stretch, but because of their inaccessibility they are not given proper attention, and they slip. A pivoted-base motor, Fig. 3, automatically takes up the stretch and maintains proper tension. These drives are similar to the standard design for floor mounting, but have special hanger arms which carry the motor horizontally. Auxiliary adjusting screws permit one man on a ladder to position the motor for correct belt and for pulley and belt alignment.

Vertical belt drives are trouble makers unless some means is provided to maintain automatically correct tension in the belt, as in Fig. 4. Belt weight is carried by the upper pulley and on

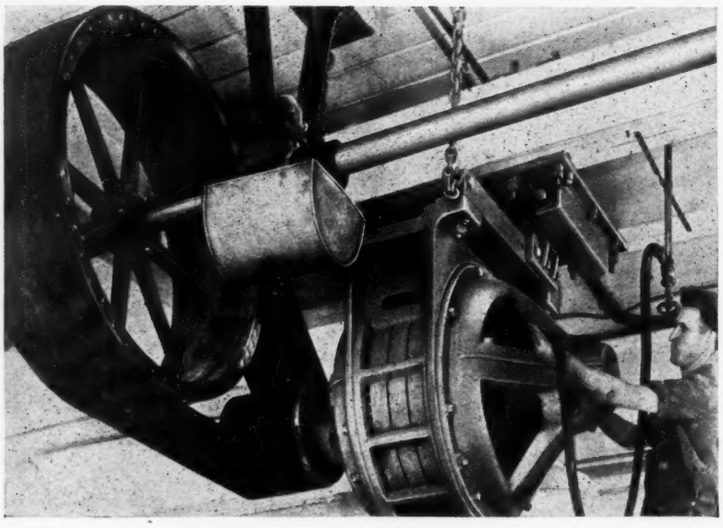


Fig. 9—Ceiling-mounted 85-hp, 860-rpm induction motor on pivoted base, drives line-shaft by flat belt on 16- and 48-in. pulleys

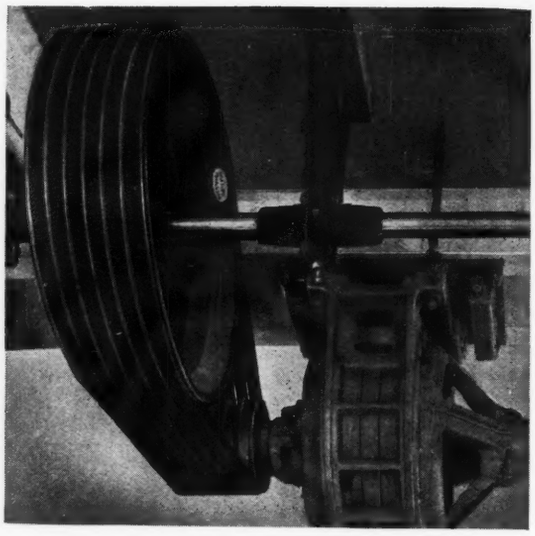


Fig. 10—An 85-hp, 860-rpm induction motor on pivoted base drives lineshaft by a multiple-V belt

fixed centers belt tension is usually inadequate to maintain proper belt contact with the lower pulley.

With the vertical pivoted base, Fig. 4, the motor is mounted on two adjustable arms supported on the pivot shaft *P*. The weight of the motor is counterbalanced by two spiral springs *S*, connected to the arm brackets. When the motor is above the driven pulley, the springs are adjusted to support motor weight plus necessary belt tension. With the motor below the driven pulley, springs are adjusted to support only that portion of motor weight not needed for belt tension.

To simplify location of the motor in relation to belt length at time of installation and to provide adjustment for belt elongation in service, pivot-shaft *P*, which carries the motor arms, can be moved vertically by adjusting screws. These screws also permit easy alignment of the motor shaft with the driven shaft to assure true belt alignment.

Selecting Belts

When applying belt drives, remember that you cannot select them on the basis of motor horsepower alone. This also applies to any kind of mechanical power-transmission equipment. Select belts with sufficient capacity for the maximum load of the driven machines, with proper allowance for motor starting torque. When in doubt, it is far more economical to over belt than to under belt. A little excess capacity in belts more than pays for itself by increased life and reliable service, where an overloaded belt will be a source of trouble and expense.

This is emphasized by Table I for multiple V-belts, compiled from data originating in the engineering department of the Goodyear Tire & Rubber Co. On the basis of 10 belts being the normal required to drive the load, one additional belt will increase drive life 40% where one less belt will decrease its life 35%. In other words, spending 10% more for belts gives a 40% return on the whole investment, where spending 10% less than normally required results in a 35% loss on 90% of normal investment.

Effect of Sheave Size

Effect of sheave sizes on multiple-V-belt life is shown in Table II. Taking a 10-in. sheave as normal, a 11-in. sheave will give 65% more belt life and a 9-in. sheave 41% less belt life than with the 10-in. sheave. Of course these figures are based on operating the belt with correct tension for each of the three conditions.

What is shown in Tables I and II for multiple V-belts applies with equal force to flat belts and bring home the fact that money spent to get the correct belt drive pays big dividends.

Follow motor manufacturers' pulley specifications whenever possible. Do not use minimum-diameter pulleys unless necessary, for they are for nameplate rating of the motor without overload. Every motor has a standard pulley size that will give a satisfactory drive. In many cases it is economical to use a pulley larger than standard, but it is a safe rule never to use smaller ones unless drive requirements make it necessary.

Figs. 5 to 10 show applications of pivoted bases to a wide range of drives. Fig. 5 is a 375-hp, 450-rpm synchronous motor connected to a flour mill lineshaft by a 36-in. flat belt on 40 and 80 in. diameter pulleys, with 72-in. center distance. At the other end of the scale is the 3-hp gearmotor, Fig. 6, with a 5.5-in. pulley belted to the 108-in. flywheel of an old Corliss engine in the Museum of Science and Industry, New York, N. Y. Here the pulley ratio is 1 to 20 and starting is frequent from pushbutton by the visitors. These and other applications shown by the photographs indicate that short-center belts are available for practically any drive.

TABLE I — EFFECTS OF TENSION ON THE LIFE OF MULTIPLE V-BELTS

Number of V-Belts	*Percent Life*
12	200%
11	140%
10 (Normal number of belts)	100%
9	65%
8	41%
7	23%
6	13%
5	6%

TABLE II — EFFECTS OF SHEAVE DIAMETER ON THE LIFE OF MULTIPLE V-BELTS

Sheave Dia. (C Belts)	*Percent Life*
12 in.	260%
11 in.	165%
10 in. (Normal Sheave Diameter)	100%
9 in.	59%
8 in.	30%
7 in.	15%
6 in.	6%

Readers' Problems

Questions for Our Readers

Condenser for Evaporator

Question 1

We are operating a triple-effect evaporator producing about 60 tons of distilled water daily. Pressure in the first effect is 5 lb gage, and a 26-in. vacuum is carried in the condenser, which has a condensing surface of 5 sq ft per lb of steam and is equipped with a rotary vacuum pump driven by a 5-hp motor. A centrifugal pump handles distilled water; condensate from the drums flows to the condenser where it is deaerated and cooled.

Wanting to increase capacity to 100 or 120 tons without greatly increasing steam consumption, we purchased three effects of the same size which we plan to place in series with the present three effects. Steam pressure will be increased to 40 lb gage. We would like to know whether the size of the condenser and vacuum pump must be increased. Another stand of atmospheric cooling coils will be added to the present one to take care of the added distilled water.—BTH

Feed-Pump Trouble

Question 2

THE FEEDWATER *system on our 425-lb, 725-F turbine installation has been changed from vacuum system to a gravity system. Formerly a centrifugal condensate pump discharged to the surge tank, having a vent to the main condenser. A combined booster-drain pump took suction from the surge tank, discharging through various heaters to the main feed-pump suction. Now a combination condensate-booster pump takes suction from the main condenser, discharging through inter-condenser drain cooler, first-stage heater, after condenser, and second-stage heater, to a tank located 50 ft above suction of feed pump. Feedwater flows by gravity to feed pump. Temperature to the tank is about 214 F, at the suction of the feed pump 210 F. When the feed pump speeds up, a violent vibration occurs in the suction line, although hydrostatic head is approximately 15 lb. Reducing suction temperature has no effect. What else could cause this?*

Occasionally a violent rattling like a water hammer is heard in the main condensate pump, except when pump is slowed down sufficiently to allow level in condenser to rise. Is capacity of condensate pump too great, causing dead circulation with water hammer?—RAS.

Suitable answers from readers will be paid for if space is available for publication.

Water Hammer

Answers to October Question 1

The Question

BURSTING *of several lead bends during the past few months has called attention to what seems to be excess pressure created by the quick closing of an automatically operated valve on a washing machine. Water-main size is 8 in., and pressure is 100-150 lb. Laundry supply is taken directly from main, reduced to 55 lb, and piped to the washing machine. An air chamber inserted on the low-pressure side of the reducing valve consists of a 4-in. pipe, 48 in. long. Water is drawn through the automatic valve, which closes suddenly when the proper level has been reached in the machine. The amount of water drawn varies from 50 to 200 gal.*

The question is, does the sudden closing of the automatic valve create an excess pressure sufficiently high to burst a ¾-in. lead bend, which is taken off the main 300 ft from the laundry. If so, how can we overcome this difficulty?—FJG

Change Automatic Valve

CONSIDERING the damage reported by FJG, one would suspect that the air chamber may not be functioning at all, as a chamber of the size mentioned should materially reduce water-hammer shock, if properly located and in first-class condition. It should be placed back of the valve on a short dead-end extension of the water line to the machine, close to the valve and connected as directly as possible. The chamber must be absolutely air tight. Many such chambers, made up of pipe and fittings, while they remain water tight, will allow air to leak off. All joints on such a unit should be carefully welded or brazed.

However, the quick closing of the 4-in. valve appears to be the underlying cause and therefore it seems advisable to replace this valve with one of the common float type which would close gradually as the machine filled with water. If this is not practical, it might be possible to fit the present valve with a spring or a dash pot to dampen out the quick cut off and allow the valve to close in a smooth manner.

Jersey City, N. J. I S CHAMBERLAIN

Add Relief Valves

THE AUTOMATIC valve, closing rapidly, permits high-pressure water flow to apply a severe shock on the low-pressure piping, due to the inability of the reducing valve to close as rapidly. Under these conditions, this water hammer will occur regardless of the presence of an air cushion. The real remedy lies in slowing down the cut-off at the automatic valve, by using a float-operated gate valve or a plug cock, or by installing a spring, adjustable from outside, on the existing valve. If this can't be done, I suggest replacing the lead bends with thoroughly annealed copper pipe. As a further protection, a relief valve should be placed at the sharpest bends on these pipes, the discharge to be salvaged, if economically possible.

Kearney, N. J. GEORGE MCNALLY

Change Pipe Material

BEFORE the water hammer question propounded by FJG can be solved, the gpm taken by the washing machine must be known. Assuming 100 gpm, the velocity in the 8-in. main will be 0.64 fps. Using the basic formula for pressure rise:

$$h = \frac{aV_o}{g}$$

where a=velocity of pressure wave, fps. (4160 for 8-in. Class D cast iron)

V_o=change in velocity of flow, fps

g=32.16

the increase in pressure due to instantaneously stopping the flow is 82.9 ft of water or 35.8 lb per sq in.

Under these conditions, pressure in the main rises to something between 136 and 186 lb, which is more than ¾-in. lead pipe will stand. The Lead Industries Association Standards prescribe AAA or XXS pipe for pressures between 75 and

MANY STATES have adopted boiler codes based, in most cases, on the ASME Boiler Construction Code. By formulating experience and known facts, these codes promote safe boiler-plant operation. They will work most effectively if they are understood as well as followed. Printed below is a paragraph from the ASME Code. Read it, and consider the reasons for the rule. Then turn to page 138 and check your thinking with the discussion given there.

SAFETY-VALVE SPRINGS

P-284: "Springs used in safety valves shall not show a permanent set exceeding one percent of their free length ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least one-tenth the diameter of the seat before the coils are closed or before there is other interference."

100 lb per sq in. Obviously ¾-in. pipe of this weight is too light, even for the static pressure involved. Using an allowable fibre stress of 190 lb per sq in. (Lead Industries Assn), the ¾-in. pipe should have a wall thickness of 0.37 in. to stand 186 lb per sq in.

The simplest way to correct the trouble would be to replace the lead pipe with pipe of other material such as copper. Installing an air chamber on the high-pressure side of the reducing valve would help some. This additional chamber must be equipped with means for maintaining the air cushion as most such chambers become water logged quickly.

St. Louis, Mo. W V WEIR

Use Shock Ram

WHAT HAPPENS in FJG's case is that when drawing water for the washing machine, the body of water in the pipeline is moving at sufficient velocity at the instant the automatic valve closes to produce a considerable pressure rise due to inertia of this weight of water. I would recommend that the air chamber be changed from the low-pressure side of the reducing valve to the high-pressure side, thus placing the air chamber on the side of the automatic valve where it would perhaps relieve the water hammer shock.

However, it is my opinion that the only satisfactory remedy would be the installation of a shock ram on the water main, somewhere near the point where the lead bends are taken off the main. This shock ram consists of a suitable cylinder fitted with neck ring and packing gland through which is supplied an ordinary plunger, the outer end being fitted with suitable springs which resist the motion of the plunger. When excess shock occurs in the line, it moves the plunger outward against the tension of the springs. These shock rams are always a part of the piping system in hydraulic installations in connection with presses and punches, and are also used in cases like FJG's.

Hartford, Conn. HARRY W BENTON

Air Chamber Inadequate

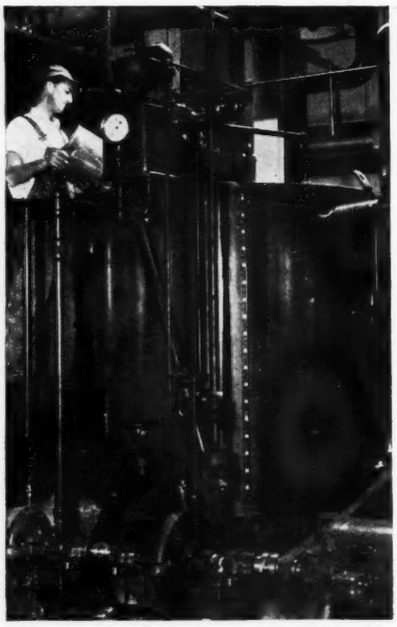
THERE is little doubt that the lead-bend failure is due to water hammer from the sudden closing of the automatic valve. Depending on the size of supply and the water velocity, a pressure of 1000 lb psi may build up, and the maximum intensity may even be in the main line rather than at the point of origin. The key to the problem lies in that piece of 4-in. pipe referred to as an air chamber. This designation is a gross misnomer and its only effect is to give FJG a false sense of security, as is evident from the following simple analysis:

A piece of 4-in. pipe, 48-in. long, has a cubic content of approximately 0.35 cu ft. The pipe originally contained this much air at atmospheric pressure; subsequently a pressure of 55 lb was built up in the line causing the air in the chamber to be compressed in proportion to the absolute pressure, so that the final air volume was

$$V_2 = \frac{0.35 \times 14.7}{69.7} = 0.074 \text{ cu ft}$$

Thus it is seen that the total cushioning volume of this so-called air chamber is about two quarts, merely a large bubble for the job it is expected to do. In addition, air has a nasty habit of being absorbed by water, which is the chronic ill of many a good-looking air chamber. If FJG will replace with a real air chamber containing at least 2 cu ft or more, and if, in addition, he will connect a compressed-air line to the chamber to force out the water and replenish absorbed air, his slumbers will no longer be disturbed by nightmares of broken lead bends.

Old Bridge, N. J. A J LUBELEY



FEEDWATER FELLOW

This gentleman is adding chemicals to a feedwater proportioner in the power plant of Ternstedt Trenton Div of General Motors, N. J.

Check Air Chamber

IF THE AIR chamber works and is not situated too far away from the line for its cushioning effect to take place before the impact wave travels to the lead bend, it should protect the set-up. But unless FJG takes pains to see to frequent recharging or provides automatic maintenance of the air cushion, he will find it vanished like a pay check at Christmas.

Absorption of air by water under pressure will empty a small chamber such as he has in a short time, and instead of a body of air under pressure, there is only a slug of water riding uselessly on the line. Sight glasses on the air bottle or chamber will soon demonstrate to FJG the need for maintenance of an air supply under pressure. If he will check this and assure an air cushion attached as closely as possible to the service pipe, he will cure his water hammer trouble and the lead bends will stand up.

Longview, Texas ELTON STERRETT

Move Air Chamber

FJG'S PROBLEM may be solved by putting the air chamber on the supply side of the pressure-regulating valve. Put a tee or Y fitting near the end, or an ell at the end of the main supply line, with the air chamber in said fitting, or put an air chamber on the supply side and next to the regulating valve, with an extra air cushion near the lead bend.

Chester, Pa. FRANK MCLEAN

Several Solutions

IF THE TROUBLE dates back to the time of installation, either (1) the reducing valve is not suited to the conditions, (2) the orifice of the automatic valve is too large for the pressure, or (3) the pipe is too small, causing high velocity and consequent great hammer on interruption. If the trouble is of recent origin, (1) there is a leak in the air chamber, (2) the reducing valve is out of adjustment, closing too slowly after the automatic valve, (3) the low-pressure connection to the reducing-valve diaphragm is kinked, corroded, or otherwise obstructed, causing failure of valve to act properly, or (4) rust blisters have formed inside pipe, causing same effect as if the pipe were too small at installation. To remedy the condition, (1) test air chamber for leakage, (2) overhaul or replace reducing valve and adjust it properly, (3) install a larger pipeline from the main to the washing machine, using the same automatic valve with a reducing connection just ahead of it. The small line with the resulting high velocity is the most likely cause of the hammer.

Menard, Ill. MARVIN WHITE

A Similar Experience

FJG will find the answer to his first question in the new Kent handbook, volume 1, page 2–22:

". . . When a valve in a pipe is closed while the water is flowing, the velocity of the water behind the valve is retarded and a dynamic pressure is produced. When the valve is closed quickly this dynamic pressure may be very great. It is then called "water-hammer" or "water-ram", and it causes in many cases fracture of the pipe. . . ."

Several years ago we had an experience similar to FJG's. The cooling water of our oil engines drains into a concrete pit from where the water is transferred to an overhead tank where it is used for boiler makeup and hot storage. City water under 55-lb pressure is admitted to the pit through a 2-in. automatic valve when the oil engines are not running and the water level has gone down to 2 ft. Under normal operating condi-

(*Continued on page* 130)

Power Lines

POWER'S History

POWER was founded in 1884 by E P Harris and H M Swetland. With it was incorporated *Steam*, which had been started by N Hawkins in Chicago two years earlier.

In 1903 POWER purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine.*

In 1908 POWER absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Steam Engineering and The Mechanical Engineer.* When *The Engineer* was purchased, the name of the combined magazine was *Power and the Engineer.* The title was condensed to POWER in 1911. All rights to the above titles reserved.

NAPE High Jinks Planned by No. 44

Members of Stevenson No. 44, New York's largest NAPE Association, have turned on the superheated steam for their entertainment and dance—Saturday, Jan 21. These annual affairs at the Riverside Plaza (73rd St, near Broadway) have gained fame for capacity (1,500 folks, or more, on the floor), rpm, decibels, kilocycles, and low demand charge ($1.00 at the gate). Savery F Coneybear, 140 Cedar St, New York, is handling reservations.

Barry Brant's musicians will synchronize the engineer hoofers. Other professional talent will include "International Revelers", a troupe of eight young-lady dancers, formerly with Paul Whiteman; John Uppham, well-known baritone of radio and opera fame; Al Verdi and Company, musical comedians; Paul and Ester, nationally known skating and dancing team; also Peggy Adams.

The affair will be open to all regardless of sex, NAPE membership or engineering status.

PERSONALS

E P ORDWAY was chosen president of Union Steam Pump Co, Battle Creek, Mich., in December. Mr. Ordway has been with the company for 31 years, and was formerly vice-president and chief engineer. He received his engineering education at the U. S. Naval Academy.

LEWIS B SWIFT has succeeded Herbert J Winn as president of Taylor Instrument Cos, Rochester, N. Y. Mr Winn is now chairman of the Board of Directors. Mr Swift was graduated from Cornell University in 1912, and since 1934 has served as vice-president in charge of engineering and research for Taylor.

S J MARTIN has been appointed manager, Engineering Dept, Pittsburgh Piping & Equipt Co, Pittsburgh, Pa. Mr Martin was graduated in mechanical engineering from Carnegie Institute of Technology in 1908. Since graduation, he has been associated in many capacities

S J Martin

with the piping industry in the design, fabrication and erection of power and process piping Before coming to Pittsburgh Piping, Mr Martin was superintendent of erection at the new Irvin Works of Carnegie-Illinois Steel Corp.

OTTO TETZLOFF was recently named chief engineer of the Homeopathic Hospital of Rhode Island, Providence. He succeeds Walter F Shea, who died last year. Mr Tetzloff has been engaged in power-plant operation for 32 years, and has been assistant chief at this hospital since 1925.

Meetings

American Institute of Electrical Engineers—*Winter Convention, Jan 23–27, New York, N. Y. H H Henline, national secretary, 33 W 39th St, New York, N. Y.*

American Society of Heating and Ventilating Engineers—*Annual Meeting, Jan 23–26, William Penn Hotel, Pittsburgh, Pa. A V Hutchinson, secretary, 51 Madison Ave, New York, N. Y.*

American Society of Mechanical Engineers—*Spring Meeting, Feb 23–25, St. Charles Hotel, New Orleans, La. C E Davies, secretary, 29 W 39th St, New York, N. Y. Concurrently, there will be held the annual meeting of the Louisiana Engineering Society.*

American Society of Refrigerating Engineers—*26th Spring Meeting, May 22–23, Hotel Hershey, Hershey, Pa. Headquarters office, 37 W 39th St, New York, N. Y.*

National District Heating Association—*Annual Meeting, June 27–30, Hotel Pennsylvania, New York, N. Y. W H Sanford, secretary, 1317 Spruce St, Philadelphia, Pa.*

N T Chadderdon

New president of Fisher Governor Co, Marshalltown, Iowa, succeeding the late Jasper H Fisher, former president and founder

STRAWS

Pointing the way business winds blow

ARKANSAS——Little Rock plans central pumping station for water system in North Little Rock, with installation of motor-driven pumping units and auxiliary equipment. Cost over $40,000. Public Works Dept, in charge.

Board of Hempstead County Commissioners, Hope, plans central-heating plant in new 4-story courthouse building. Cost about $200,000. McAninch & Anderson, Insurance Bldg, Little Rock, architects.

CALIFORNIA——U. S. Indian Irrigation Service, Los Angeles, contracted Worthington Pump & Machinery Corp, at $21,000 for two centrifugal pumping units and accessories, for installation at Flathead Indian Irrigation project, Mont.; also for one additional centrifugal pump at $9975, and quantity of spare parts at $2675, for same project.

Walt Disney Enterprises, Inc, Los Angeles, contracted General Electric Co, for air-conditioning system in new motion picture studios in San Fernando Valley area. Over 15 buildings will be built, later to be increased to about 25 studio units.

Public Works Officer, Naval Training Base, San Diego, has low bid from Fairbanks, Morse & Co, at $35,390, for two 100-kw diesel-generating sets and accessory equipment for power plant on San Clement Island, and award is scheduled to be made at early date.

Public Works Officer, Naval Training Base, San Diego, contracted Walter H Barber, San Diego, for extensions in steam-distributing system at local naval operating base at $27,887.

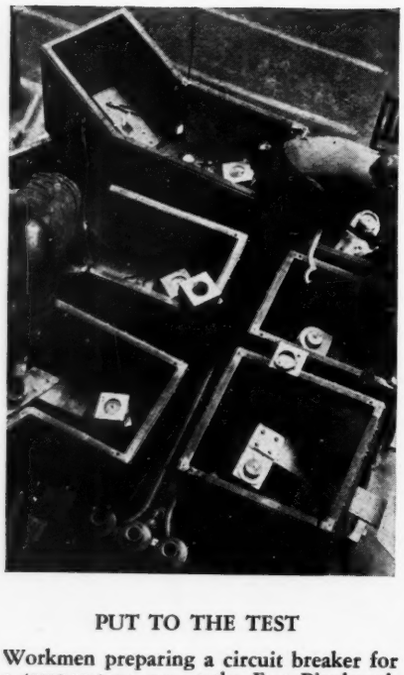
Ventura has plans maturing for water-softening plant for municipal water system. Proposed to begin work early in 1939. Cost about $140,000. Taylor & Taylor, 725 South Spring St, Los Angeles, consulting engineers.

COLORADO——Board of Water Commissioners, Denver, will soon make awards for pumping station and equipment for waterworks system; reservoir will have capacity of 5,000,000 gal. Cost about $120,000. D D Gross, chief engineer.

Lamar will soon make awards for extensions in municipal power plant, including new 2000-kw turbine-generator, 2500-sq-ft surface condenser, boiler unit with capacity of 30,000 lb of steam per hr, and complete auxiliary equipment. Cost about $200,000. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

Bureau of Reclamation, Washington, D. C., contracted Warner Construction Co Inc, Chicago, Ill., for construction of Green Mountain dam and hydroelectric plant on Blue River, about 16 miles from Kremling, at $4,226,206.20, exclusive of power station equipment. Power plant will be equipped for initial capacity of 24,000 kva. This is part of Colorado-Big Thompson project (Specifications 797).

CONNECTICUT——State Dept. of Public Works, Hartford, contracted G W Cunningham Co, at $26,826 for installation of



PUT TO THE TEST

Workmen preparing a circuit breaker for a temperature run at the East Pittsburgh Works of Westinghouse Elect & Mfg Co. 3000 amp will be passed through the breaker and its connections until a constant temperature rise is reached

steam-distribution system at State Home for Soldiers, Rocky Hill, Conn. Also, let contract to Theodore D Bross Co, for outside electrical work, same institution, at $45,888.

FLORIDA——Wauchula will award contracts soon for improvements in municipal electric plant, including 250-kw diesel-generator unit and auxiliary equipment. C K S Dodd, Sarasota, consultant.

Orlando plans extensions in municipal electric plant, including additional generating units and auxiliary equipment for increased capacity. Cost close to $800,000. Robert & Co, Bona Allen Bldg, Atlanta, Ga., consulting engineer.

GEORGIA——Southern Mining & Power Co, Dahlonega, plans power house at local mining properties. Financing in amount of $350,000 is being arranged for this and other buildings and development.

ILLINOIS——Cook County Board of Commissioners, Chicago, plans boiler house at new county convalescent hospital, consisting of several units, to cost about $1,000,000. Fund of $450,000 has been arranged through Federal aid. Eric E Hall, 123 West Madison St, architect. A boiler plant also will be built at proposed new county contagious disease hospital, estimated to cost a like amount, and for which, similarly, a $450,000 grant has been secured through Federal aid.

INDIANA——Board of County Commissioners, Richmond, will soon begin construction of 1-story addition to boiler house at county institution near city, 26 x 76 ft. Additional boiler unit and auxiliary equipment will be installed. Cost about $27,500. C E Working, 2002 E Main St, Richmond, architect.

Board of Trustees, Indiana Boys' School, Hammond, will award contract soon for power house for central-heating service at institution. Cost over $175,000. J M Rotz Engrg Co, Merchants' Bank Bldg, Indianapolis, consulting engineer.

Logansport will award contracts soon for 7500- to 10,000-kw turbine-generator and auxiliary equipment, surface condenser and accessories for installation in municipal power plant.

Garrett plans improvements in municipal power plant, to include 3600-sq-ft water-tube boiler, superheater, traveling-grate forced-draft stoker, automatic combustion-control equipment, pumping units and complete accessories. Bevington-Williams, Inc, Indiana Pythian Bldg, Indianapolis, consulting engineer.

IOWA——Cascade will soon begin construction of municipal electric plant. Proposed to use diesel-generating units and accessories. Cost about $110,000. Financing has been arranged. Young & Stanley, Inc. 211 Iowa Ave, Muscatine, consultant.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Crossett—Crossett-Watsek-Gates Industries, Inc., plans constructing addition to paper mill, incl. power house and equipment. $700,000.

Calif., Truckee — Truckee Public Utility Dist. defeated $66,000 bonds for constructing power plant on Truckee River. Total est. $120,000. PWA allotted $54,000 grant.

Conn., Hartford—City, Metropolitan Comn., plans installing power generating equipment at South Meadows sewage disposal plant to supply all electric power for plant, incl. 500 hp. engine generator to burn waste gas, a plant by-product. $30,000. W. Alfred Wurts, Municipal Bldg., 550 Main St., engr.

Ga., Atlanta—Georgia Power Co., Mr. Hammond, ch. engr., Electrical Bldg., will spend during 1939, $2,000,000 for distribution lines, $1,000,000 for transformers, substations and minor improvements to generating plant and $1,500,000 for railways and buses.

Ill., Chanute Field (Rantoul P. O.)—Bids Dec. 22, by Con. Q.M., constructing superstructure central heating plant. $450,000.

Ind., Garrett — Bd. P. Wks., F. L Feick, chn., soon takes bids constructing municipal power plant improvements, incl. one 4 drum 360 hp. water tube boiler, soot blowers, traveling chain grate stoker (motor driven), super heater, ash conveyor, coal weigh larry and track, concrete and fire brick foundations, 175 ft. 7 ft. diam. radial brick stack, cooling tower 21x61x32 ft. high and three 132 in. air fans, spray eliminators. $100,000. PWA project. Bevington Williams, Inc., 1139 Ind. Pythian Bldg., Indianapolis, consult. engrs.

Ind., Jasper—Bd. P. Wks., J. Giesler, clk., soon takes bids constructing municipal power plant improvements, incl. one 515 water tube boiler, forced draft chain grate stoker (motor driven), soot blower, super heater, boiler feeders, combustion control equipment. $35,000. PWA project. John M. Rotz Eng. Co., 817 Merchants Bank Bldg., Indianapolis, consult. engrs.

Ind., Plainfield—Bids Dec. 24, by Indiana Boys School, E. M. Dill, supt., 3 boilers, soot blowers, grate stokers, fire brick boiler, generators, piping, switchboard, pumps, water softener, coal handling equipment, etc., for electric light and power plant and waterworks. $180,000. PWA. J. M. Rotz Eng. Co., 817 Merchants Bank Bldg., Indianapolis, mechanical engrs.

Ia., Anita—Town approved $111,000 bonds, constructing municipal electric light plant. A federal grant will finance remainder of project.

Ia., Cedar Falls—Iowa State Teachers College, B. Boardman, bus. mgr., plans constructing rein.-con., brick, stone power plant. Est. about $45,000. E. E. Cole & A. A. Mann, Des Moines, engrs.

Ia., Coggon—Bids Jan. 9, by Town, improving municipal light plant, diesel engine generating unit, auxiliary equipment, repairing old engine from 2 stage combustion to open head single stage. To exceed $25,000. J. DeWoody, clk.

Ia., Harlan—Bids Jan. 19, by City, constructing municipal light and power plant, diesel engine electric generator and exciter, extra equipment, accessories, etc. To exceed $25,000. L. Billings, secy. Bd. Trustees.

Kan., Osborne—City, City Clerk, plans constructing municipal power plant improvements, etc., $53,000. Paulette & Wilson, Farmers Union Bldg., Salina, and 1006 Kansas Ave., Topeka, engrs.

Kan., Oswego—City, W. A. Blair, mayor, plans new generating units for municipal light and power plant together with accessories and appurtenances. Est. about $98,815. A. C. Moore, Willow Vista Estate, Joplin, Mo., engr.

Kan., Paola—City indefinitely postponed construction light plant. $240,000. PWA. W. B. Rollins & Co., Railway Exch. Bldg., Kansas City, Mo., engrs.

La., Lake Providence—Town plans constructing light plant, installing engine, tanks, reservoir and filtration plant. $250,000. Bond issue approved.

Mich., Sturgis — City, L. C. Waterstraut, city mgr., plans improving power plant. $274,000. PWA allotted $123,000 grant. Ayres, Lewis, Morris & May, 506 Wolverine Bldg., Ann Arbor, engrs.

Minn., Brainard—City, W. Fall, clk., defeated $390,000 bonds, constructing electric power plant, building and generating equipment to supply existing municipal distribution system. Total $934,000. PWA project. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, engrs.

Minn., Melrose—City plans constructing power plant addition and installation. $53,000. PWA allotted $23,850 grant. Elbert & Co., St. Paul, engrs.

Minn., St. Paul—St. Thomas College, J. H. Moynihan, pres., Cleveland and Summit Aves., plans by Ellerbe & Co., archts. and engrs., E 1021 1st Natl. Bank Bldg., constructing, equipping brick, concrete power plant. $250,000.

Minn., Westbrook—City, constructing munipal power plant. $67,272. PWA allotment rescinded. Buell & Winter, 508 Insurance Exchange Bldg., Sioux City, Ia., engrs.

Mo., Caruthersville—PWA rescinded grant, constructing power plant for City. $175,000. Burns & McDonnell Eng. Co., 107 W. Linwood Blvd., Kansas City, Mo., engrs.

Mo., Lees Summit—City defeated bonds, constructing new power plant. $150,000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., engrs.

Mo., West Plains—City, J. P. Harlin, mayor, and c/o A. F. Day, clk. and collector, will not build municipal light and power plant building, rein.-con., diesel engine generating unit, switchboard, auxiliaries and accessories and distribution lines. $160,000. PWA cancelled $74,700 grant. M. S. Hogan, city engr.

Neb., Auburn—City plans constructing power plant and distribution system. $342,000.

N. J., Woodbridge—Rahway Valley Joint Meeting plans constructing powerhouse and filter house for sewage treatment works. $76,725. Fuller & McClintock, 11 Park Pl., New York, engrs.

N. Y., Little Falls—Common Council plans constructing municipal power plant. To exceed $150,000. Burns & McDonnell, 107 W. Linwood Blvd., Kansas City, Mo., engrs.

North or South Carolina—Duke Power Co., 422 South Church St., Charlotte, N. C., C. I. Burkholder, vice pres. and ch. engr., plans constructing 80,000 kw. plant. $1,000,000. Site not yet selected.

O., Zanesville—Zane Refining Co., P. N. Faine, secy., Ohio Penn Grade Oil Producers Assn., Zanesville, plans constructing modern 1,500 bbl. crude oil refinery on 40 acre site along Muskingum River incl. rail sidings, marine dock, cracking unit, power plant, storage facilities, etc. $500,000.

S. D., Freeman—City, constructing power plant improvements. $100,000. PWA allotment rescinded. Buell & Winter, 508 Ins. Exch. Bldg., Sioux City, Ia., engrs.

Tex., Blanco—City voted bonds constructing municipal electric light and power system. $30,000. Engineer, c/o owner, engr.

Tex., Kermit—City, R. Clapp, mayor, plans constructing power and light plant. $200,000. Voted bonds.

Tex., Cuero—City, J. T. Newman, mayor, taking bids electric distribution and lighting system, power, receiving plant. $175,000. PWA grant. Garrett Eng. Co., 308 Hughes St., Houston, engrs.

Tex., Goldthwaite—City, c/o H. G. Bodkin, mayor, soon takes competitive bids constructing municipal electric generating plant and distributing system. $125,000. Bonds voted. PWA allotment made. W. G. Morrison, 912 Professional Bldg., Waco, engr.

Tex., Moulton—City voted bonds constructing municipal electric light and power facilities. $72,000. PWA project.

Tex., Wichita Falls—City, J. B. Miller, mayor, rescinded PWA allotment for constructing municipal power and light plant, incl. all necessary equipment and machinery and distribution system. $1,750,000.

Utah, Garland—Town, Town Clerk, plans constructing diesel engine light and power plant distribution system. $80,000. S. Margetts, Felt Bldg., Salt Lake City, engr.

Wis., Cumberland—City plans constructing power plant improvement. $95,225. PWA grant $42,075. G. L. VanFleet, Dubuque, Ia., consult. engr.

Wis., Kaukauna—City plans constructing power plant (overflow dam and power house). $474,518.

Wis., Westby—Vernon Co. Electric Cooperative, Westby, plans constructing power plant. $500,000. REA allotment. Site not selected.

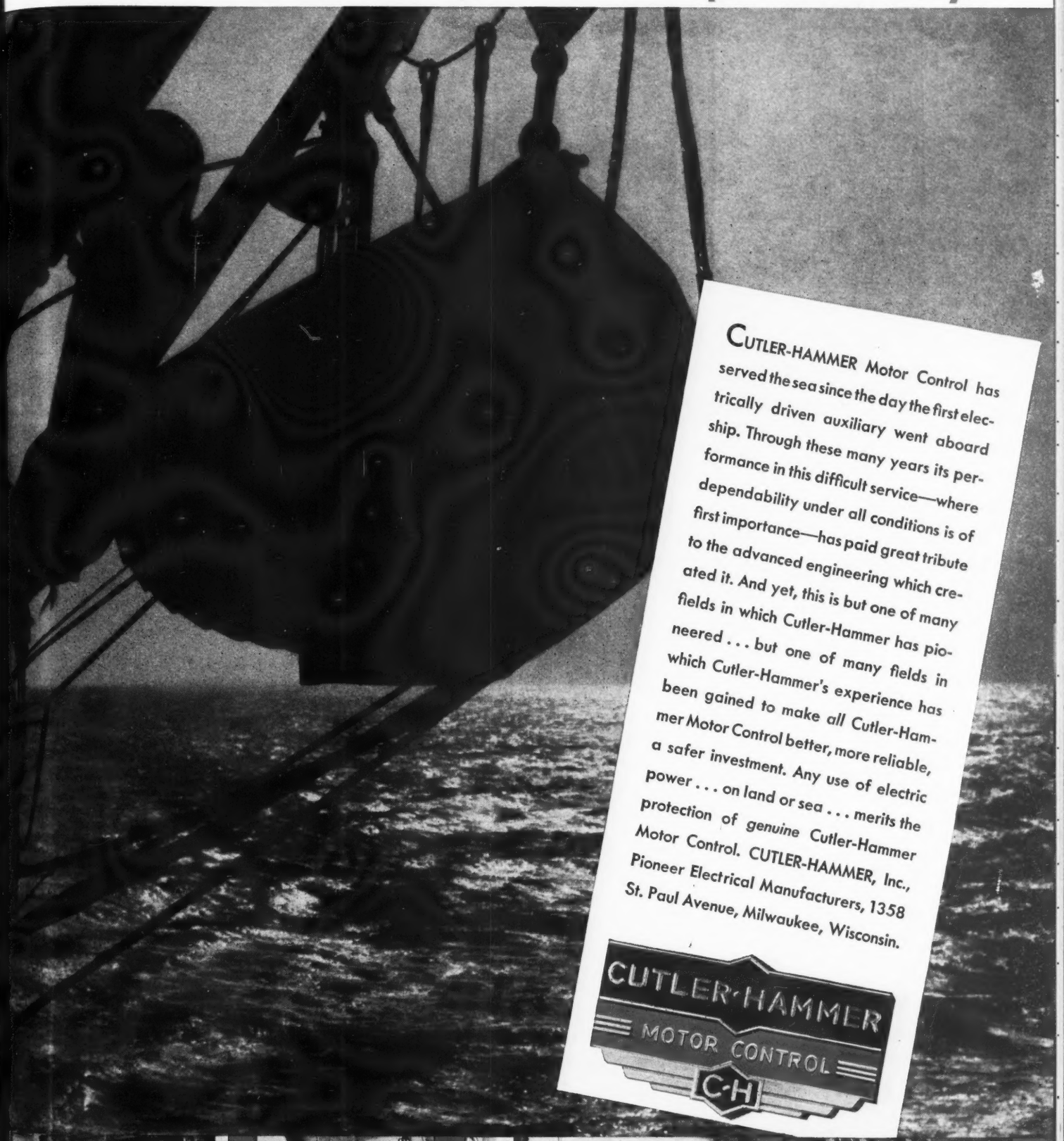
B. C., Cranbrook — Municipality, F. W. Burgess, clk., plans nearing completion constructing hydro-electric power plant on St. Marys River near Wycliffe. $90,000. D. Philpot, Town Hall, engr.

B. C., Grand Forks—Municipality, J. A. Hutton, clk., plans constructing electric plant. $100,000. Approved by Dominion Government and loan promised.

B. C., Upper Bennington—West Kootenay Power & Light Co., Ltd., constructing power development, day labor. $100,000. Private plans.

B. C., Victoria—Deep River Development Co. Ltd., plans constructing hydro-electric power development on Campbell River below Elk Falls. $750,000. Awaiting approval of Provincial Government. Private plans.

ON LAND OR SEA
there is no substitute for dependability



CUTLER-HAMMER Motor Control has served the sea since the day the first electrically driven auxiliary went aboard ship. Through these many years its performance in this difficult service—where dependability under all conditions is of first importance—has paid great tribute to the advanced engineering which created it. And yet, this is but one of many fields in which Cutler-Hammer has pioneered . . . but one of many fields in which Cutler-Hammer's experience has been gained to make *all* Cutler-Hammer Motor Control better, more reliable, a safer investment. Any use of electric power . . . on land or sea . . . merits the protection of *genuine* Cutler-Hammer Motor Control. CUTLER-HAMMER, Inc., Pioneer Electrical Manufacturers, 1358 St. Paul Avenue, Milwaukee, Wisconsin.

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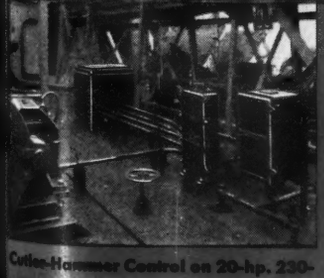
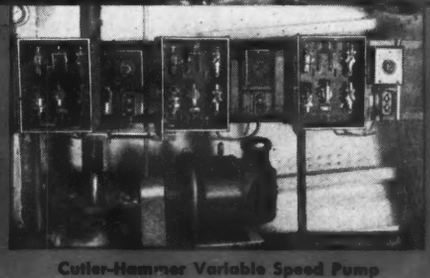
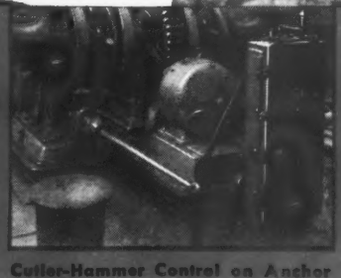


Cutler-Hammer Control on 20-hp. 230-volt motor operating mooring winch.

Cutler-Hammer Starter for Engine Room Bilge Pump.

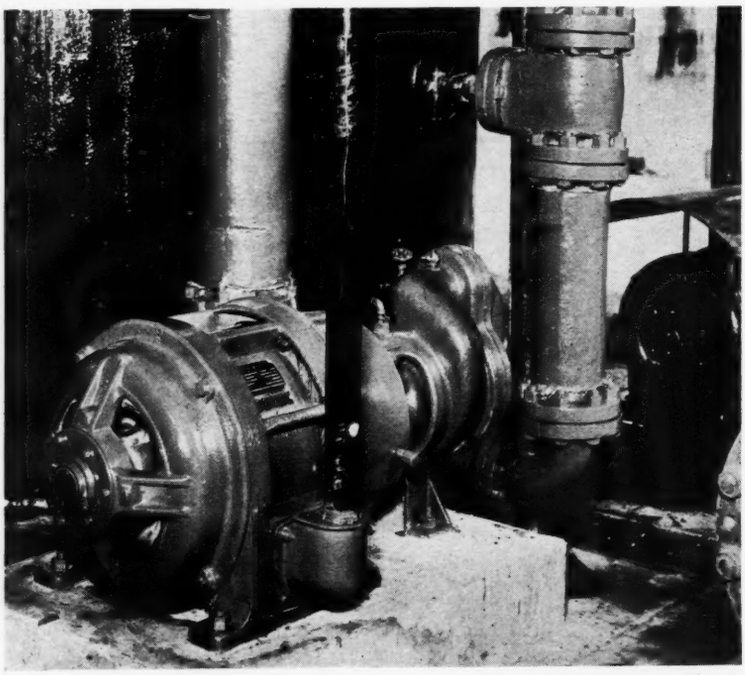


Cutler-Hammer Variable Speed Pump Controllers for Fresh Water Supply.



Cutler-Hammer Control on Anchor Windlass Motor Driven Equipment.

Practical Aids to Operation



Unit Pumps for Boiler-Feed Service

MOTOR-DRIVEN centrifugal pumps in which pump casing is integral with motor and the pump impeller is overhung on the motor shaft have found wide use for a number of years. They are made by several pump manufacturers under various trade names. Principal uses have been circulating water and other fluids for refrigeration and heat-exchange work, service water, and other low to moderate pressure uses.

A somewhat less usual application of the unit pump is for feedwater to boilers above 100-lb pressure, such as the 250-gpm, 2-stage unit delivering 210-F water at 500-ft head (210-lb) discharge pressure in use at the University of Missouri for nearly two years. The pump is driven by a 50-hp, 3550-rpm motor, with the pump impeller completely overhung on the two motor bearings. The pump thus far has been entirely successful for this service, running as quietly as when it was new and with no noticeable increase in power input. Its construction is such that when the outboard-motor-end bell is removed, the pump impeller and motor rotor balance on the inboard bearing. Solely one packing gland is required, which has maintained its packing in good shape.

The unit pump has the disadvantage of being inconvenient to overhaul, it being necessary to take the entire machine apart. However, if care is taken with the feedwater so that chemical deposits do not build up in the pump, if the packing and gland are properly sealed and kept in good condition, and if the bearings are lubricated, there should be little cause for other than an annual inspection. With due care, the advantages of the unit pump for boiler feed can be realized.

Columbia, Mo. R H SOGARD

Sticking Contactor Causes Starting Trouble

LESS than a month after installation, trouble occurred with an automatically started slip-ring motor driving an ammonia compressor. The motor failed to pick up speed as the starting contactors closed. Even when the last contactor closed, the motor would not come up to full speed. Resultant voltage drop caused the contactor solenoids to release, after which the whole starting process would begin over again. Investigation revealed a burnt-open resistor. This was patched and normal operation resumed.

A few days later the same trouble occurred, and low voltage was assumed to be the cause. On a third occasion, when starting trouble occurred at a time when voltage was known to be normal, the resistor had burned out between the third and fourth starting-contactor connections. On opening the control-panel door one day after the compressor had been shut down for several minutes, the operator discovered the third starting contactor stuck closed. A slight jar opened it. The cause of the trouble was then apparent. With this contactor closed after the compressor stopped, there was only one-fourth normal resistance in series with the rotor when the motor started. As a result, the rotor current became sufficiently high to burn out that part of the resistance in circuit. Filing the contactor points did not remedy the trouble. A spring was then placed to pull the contactor open when the solenoid was deenergized, and no further trouble from this source has been experienced.

Marissa, Ill. GEORGE BLUM

Transformer Changes Cut Power Costs

FACED with the necessity of reducing purchased-power cost in school buildings during light-load summer months, we employed two methods. Lighting load in one building is normally supplied by three 50-kva transformers with delta-connected primaries. Secondary of each transformer is arranged for a single-phase, 115- to 230-volt, 3-wire system with grounded neutral, shown in full lines, Fig. 1. In winter time, power is provided by three 75-kva transformers connected with delta-delta for 230 volts, three phase. When the power load is small in the summer, only two of these transformers, connected open delta, have been used.

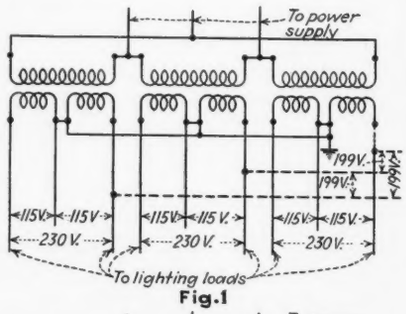


Fig.1

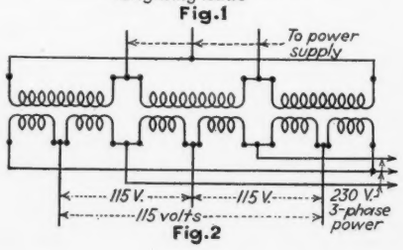


Fig.2

After some study of how to reduce transformer losses at light loads, it was decided to connect the power load to

Another New Jersey Utility Uses Yarway Impulse Traps

. . . On Superheated Steam Headers and Drain Systems

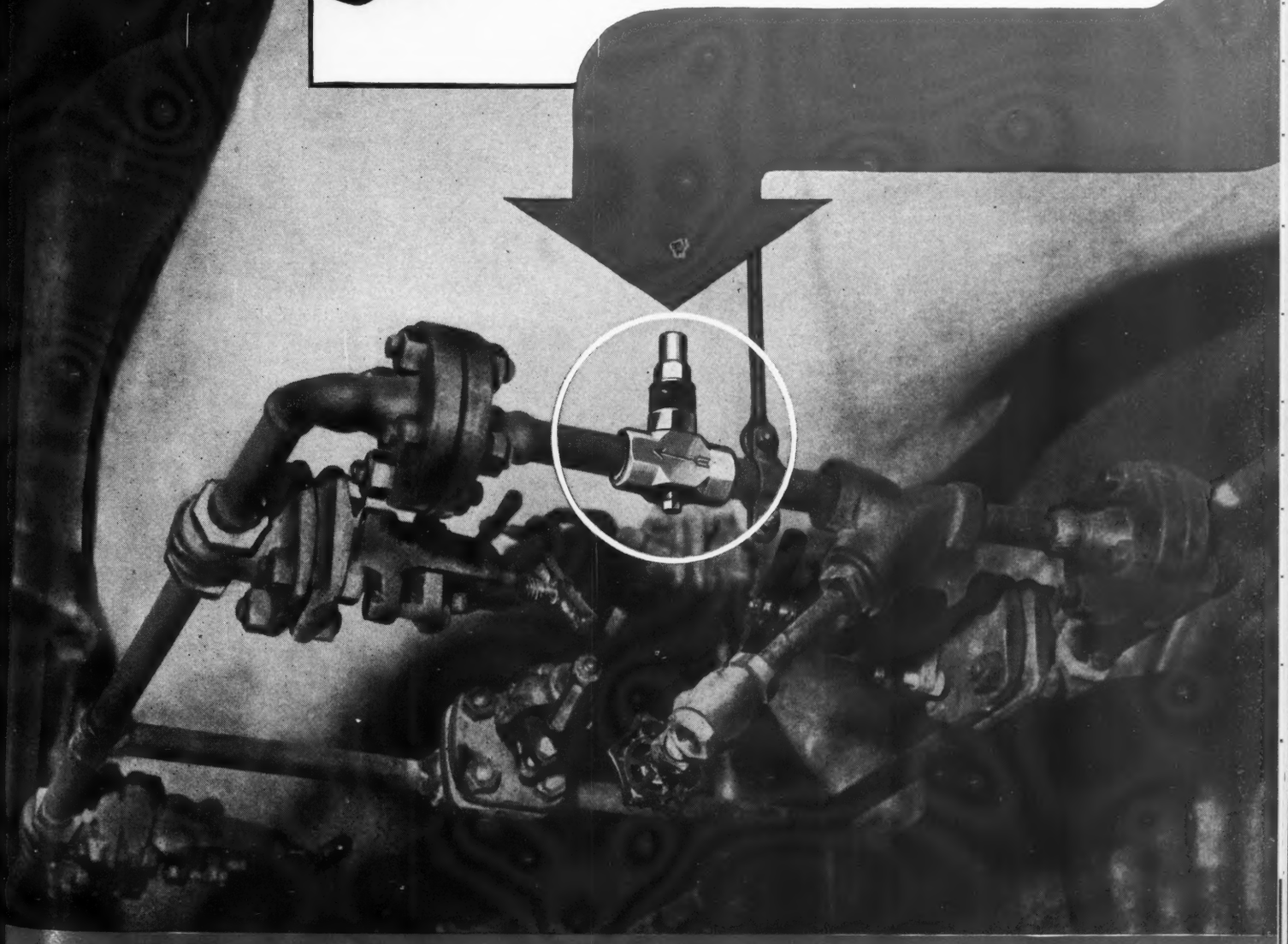
At Essex Generating Station of Public Service Electric and Gas Company, Newark, New Jersey, Yarway Impulse Steam Traps are in use on 250 pounds S. S. P. on superheated steam headers and drain systems.

Yarway Traps are replacing less efficient, less dependable devices on important equipment in many plants. More than 50,000 are now in use.

Why ? Because the Yarway is the one trap that meets all requirements. *High efficiency* — with continuous discharge on heavy condensate loads, and intermittent discharge on light loads. *Good for all pressures* within wide range without change of valve or seat. *Simple design* — easy to maintain. *Small Size, Light Weight, Straight Through Piping* — facilitating installation, saving space. *Low Price* — often making it cheaper to install a new Yarway than to repair an ordinary trap.

End your steam trap troubles with Yarway. Ask your dealer or write for Catalog T-1734.

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia



YARWAY IMPULSE STEAM TRAP

the lighting transformers, as indicated by the dotted lines, Fig. 1. This connection is the equivalent of connecting one-half of each secondary winding in star and gives $115 \times 1.732 = 199$ volts 3-phase. It was found that the 230-volt motors would operate satisfactorily on this voltage.

If necessary, the transformer could have been connected delta on the secondary side for 230 volts, but this would have involved connection complications and the lighting system could have been grounded at one point only. Therefore, since satisfactory motor operation could be obtained on 199 volts, we decided to use the star connection. This allowed disconnecting the power transformers, saving their losses and improving the load power factor.

In another school, lighting was supplied by three 37.5-kva transformers connected delta-delta for 115 volts on the secondary side, and power by two 75-kva transformers connected open-delta for 230 volts. Here a 10-kva, 3-phase transformer was installed for summer lighting and power loads. Secondaries of this transformer were connected series-delta for 230-volt, 3-phase power. Taps brought out from the center of each secondary give 115 volts, 3 phase for lighting (see Fig. 2).

The foregoing may appear to be over-exertion to save the light-load losses in the transformers. It was found, however, that these losses for the old transformers were approximately double those given by manufacturers for units of modern design, and so the changes made reduced the power bills considerably.

Altoona, Pa. A R MARKLAND

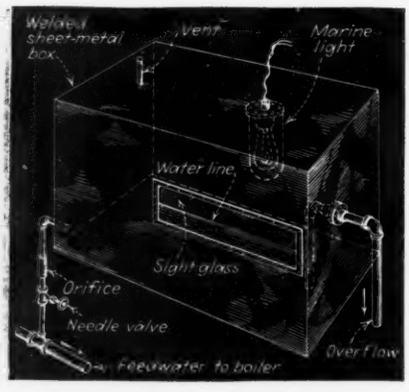
Detecting Oil in Feedwater

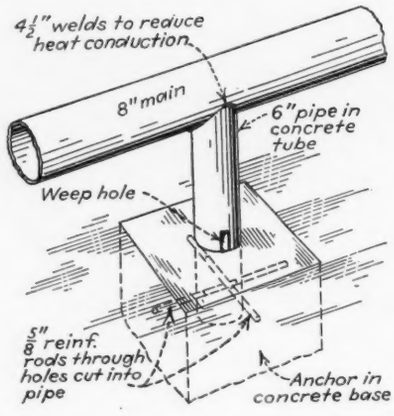
MUCH has been written about danger of oil in steam boilers. It is sufficient to say that oil often insulates boiler-heating surfaces, presenting an extremely hazardous condition. Certain inherent sources of oil exist in many plants and, due to design, cannot be entirely eliminated. Exhaust from reciprocating engines is the most common oil source, and if the condensate is utilized for feedwater, some method of purification must be used.

A periodic check on possibility of oil in the feedwater and efficiency of the purification medium should be made. The method shown in the figure is being used in some plants. An orifice in the tap from the feedwater line allow a small flow to the tank. Water level in the tank is kept constant by the overflow, at about the middle of the sight glass. As the overflow goes to the hot well, the heat loss is small. Any oil in the water tends to rise to the surface and since the overflow is taken from near the bottom of the tank, any oil in the water will remain in the tank and is therefore accumulative. In this way, a very small amount of oil in the water will be evident over a period of operation.

Each time meters are read, the operator observes and notes the condition of the water surface in the tank. In this manner, any let-down in the proper operation of the condensate-purification system will be immediately indicated by oil floating on the surface of water in the tank.

Chicago, Ill. R O BILLINGS




4½" welds to reduce heat conduction
8" main
6" pipe in concrete tube
Weep hole
⅝" reinf. rods through holes cut into pipe
Anchor in concrete base

Pipe Anchor for Welded Steam Mains

EXPANSION and contraction of district steam-heating mains is taken care of with expansion joints and anchors. In the well-known bolted flanged-joint type of construction, the flanges provide convenient points to locate the anchors. Most new work is welded, but connections to fittings are flanged and these may be used for anchoring the pipe. A much cheaper and equally effective anchor can be made as shown in the figure. A piece of pipe is anchored in concrete and its end welded to the steam main.

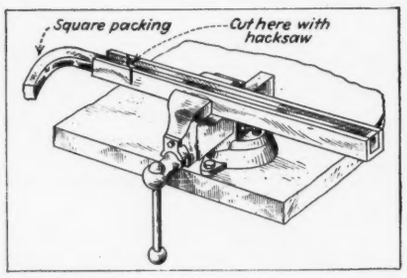
The anchor pipe should be smaller than the steam main. For example, if the main is 8 in. in diameter, use a 6-in. anchor pipe. The 6-in. pipe is embedded in the concrete anchor base. Two ⅝-in. reinforcing rods are placed at right angles through the anchor to prevent it from pulling out of the concrete slab. A weep hole cut in the side of the anchor pipe prevents formation of moisture and consequent corrosion on the inside of the anchor.

Hibbings, Minn. A L BENNETT

Cutting Roll and Spiral Packing

I HAVE found that wooden mandrels and miter boxes are very handy for cutting rod packing. For spiral packing I use a mandrel, the same size as the rod on which the packing is to be used. The cuts are made so that the ends lap to give a pressure-tight joint.

For roll packing that can be laid out straight, I use miter boxes, one for each length of packing required, as in the figure. The cut in each box is a distance from the end to give the exact length of packing required. Written on the back of the miter boxes are the size of the packing, the number of rings and quality used for the job. This helps to eliminate mistakes from the man doing the work. A thin hack-saw blade or a thin sharp knife is used to cut the packing, and the mandrel or miter box is held in a vise.



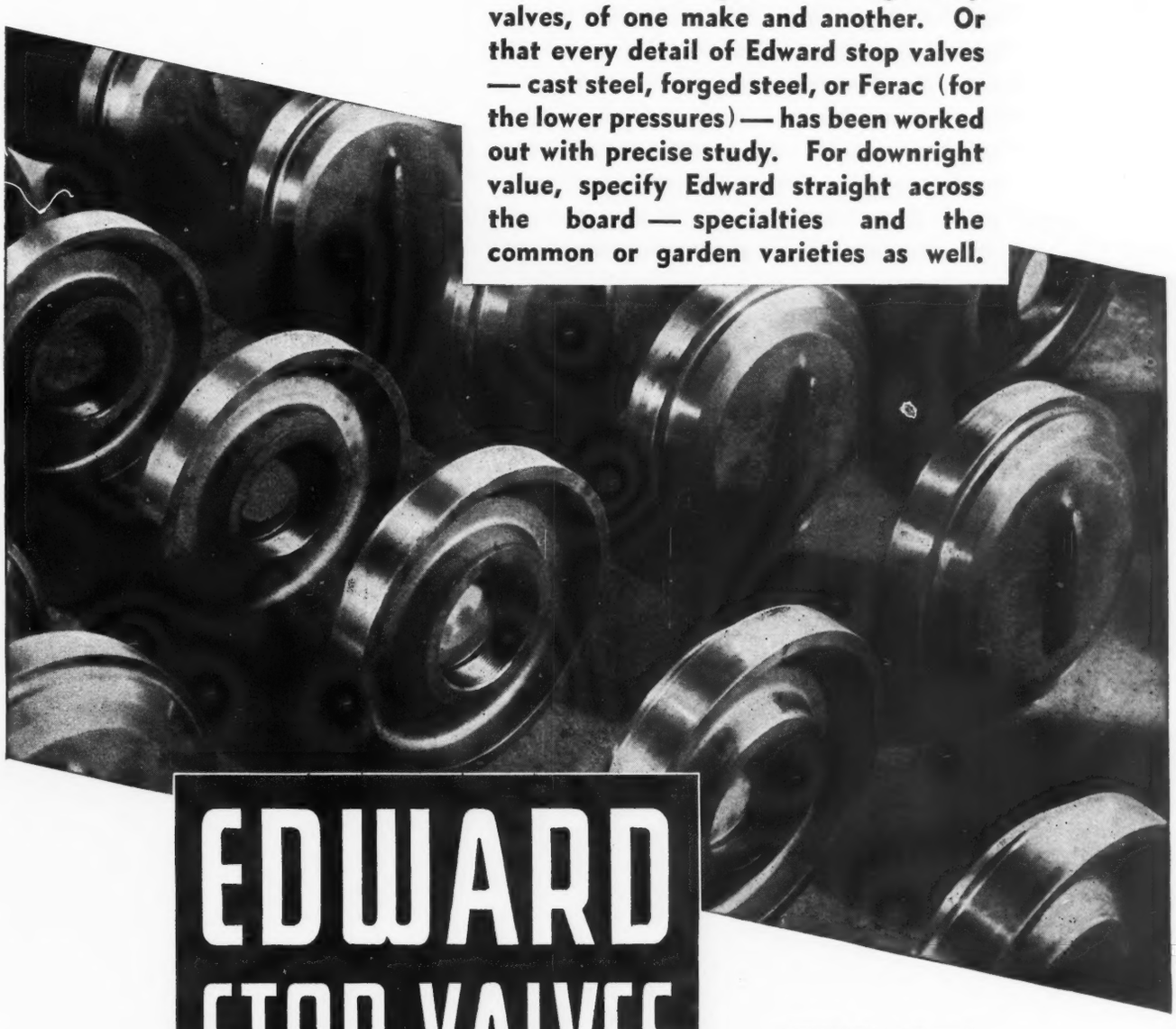
Sloat, Calif. ROY L BROWN

Emergency Lights From Control Battery

AT OUR plant it had been the custom for several years each evening to light a half dozen barn lanters kept at critical points (switchboard, turbine throttles, boiler-feed pumps and boiler controls) in event of loss of lights for any reason. The lanterns gave very little light and were a nuisance to handle, especially when trying to switch over rapidly to stand-by conections.

Since the circuit breakers are electrically operated from a 120-volt storage battery, and emergency de lighting

NON-RETURN valves, blow-offs, and feed line stop-check valves — these are admittedly down the specialist's alley. And Edward's leadership in these lines is in the record. But not every buyer realizes how much difference there is between globe and angle stop valves, of one make and another. Or that every detail of Edward stop valves — cast steel, forged steel, or Ferac (for the lower pressures) — has been worked out with precise study. For downright value, specify Edward straight across the board — specialties and the common or garden varieties as well.

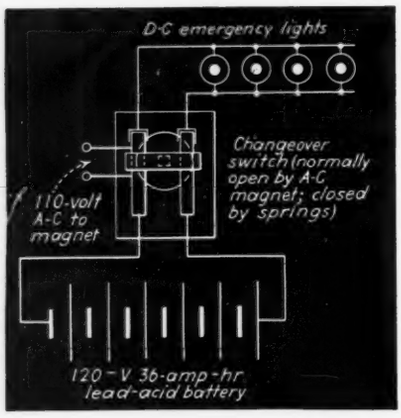


EDWARD pedigreed forged EValloy disks like these give plus value to EDWARD stop valves.

EDWARD STOP VALVES *Excel, too*

The Edward Valve & Manufacturing Co., Inc.

EAST CHICAGO INDIANA


D-C emergency lights
Changeover switch (normally open by A-C magnet; closed by springs)
110-volt A-C to magnet
120-V 36-amp-hr lead-acid battery

system was installed at the 2300-volt disconnects, 100 watts; boiler-feed pumps, 100 watts; each boiler-control board, 50 watts; and at each water column, 25 watts.

An automatic switch on the dc circuit between the lighting system and the battery is held open normally by an ac magnet. When ac fails, springs close the switch and put the dc lights in service. This installation is of considerable value in night emergencies in a small plant with only an operator and a fireman on duty.

Columbia, Mo. R H SOGARD

Safety Rules for Tanks, Boilers

FROM the standpoint of frequency and severity of injuries to personnel, among the most dangerous of maintenance jobs are those that require men to work inside boilers, tanks and similar vessels. In addition to cramped working space and poor lighting, additional hazards are often present, such as dangers of asphixiation, scalds and burns, electrical shocks, overheating of workmen, and possibility of explosions. Most accidents from these sources can be avoided if operating and maintenance crews are properly instructed in preventive safeguards.

1. Close all valves in connecting pipelines and protect them with locks or approved safety tags against unauthorized tampering. Keys of locks and authority to remove tags should remain in possession of some responsible person until the job is completed.

2. Drain equipment and where there is any possibility of hot water, steam, or other dangerous liquids and gas backing up through the drain valves, lock or tag them closed. Where drain valves are not provided, remove drain plugs or break a joint in a pipeline entering the bottom of the vessel. If no other drainage method is practical, use a suction pump to remove contents of the vessel. During the draining operation, vent valves should always be open to relieve pressure and to avoid the formation of a vacuum.

3. After draining is completed and all pressure is off the unit, remove necessary access opening covers.

4. Before entering the vessel, make sure that extension lights are so designed that there is no danger of shocks, that all valves in connecting piping and ducts are tight, that temperature is low enough so that workmen will not be overheated, that all dangerous gas or vapors within the enclosed space are removed and the air is fit to breathe, that solid materials have not accumulated within the vessel to fall and injure workmen, and that all workmen are equipped with personal safety devices.

5. After entering the vessel, make sure that some person is always stationed outside to act as a guard and observer, that scaffolding and other working platforms are safely constructed and installed, and that hazardous conditions not visible from outside are corrected.

6. While doing the job, avoid becoming overheated and at the first sign of acute discomfort from any cause, leave the vessel immediately and do not return until the cause is corrected. Use proper tools and safe working practices.

7. After the job is completed, make sure that all workmen, tools, and scaffolding are out of the unit before it is prepared for testing and operation.

8. Before replacing the unit in service, check all safety devices, such as relief valves, to be sure they have not been damaged or otherwise rendered inoperative during maintenance.

Lighting Equipment

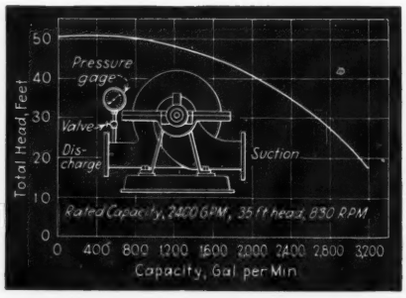
Proper lights used inside boilers or tanks have current-carrying parts sealed against the entrance of liquids and are equipped with vapor-proof globes, heavily constructed metal guards, and 3-conductor flexible cords especially insulated to withstand abrasive and cutting action. Connect one end of the third conductor to exposed metal parts of the light assembly and ground the other end outside the vessel. In some plants extension lights are equipped with low-voltage bulbs supplied from step-down transformers.

Condition of the air in vessels used for water and steam service can be checked with a lighted candle, as air that will support combustion is ordinarily satisfactory for human respiration. Open flames should never be used, where the vessel has contained inflammable vapors or liquids. In such cases special precautions must be taken and are best determined by consulting the underwriters' rules.

Roanoke, Va. S H COLEMAN

Pressure Gage Used to Estimate Water Flow

IN PLANNING plant expansion, designing new equipment, or distributing power costs, it is often necessary to estimate the water supplied by centrifugal pumps in large industrial plants. Usually the installation of expensive metering equipment is not justified for these purposes. Particularly is this true when it is necessary to check the flow from a number of small pumps. A head-capacity curve, such as supplied by the pump manufacturer, used in combination with a Bourdon-type pressure gage placed on the discharge opening of the pump, as in the diagram, will help to give a good indication of the quantity of water being pumped. The suction head must be considered, but this can usually be calculated, making it unnecessary to install a manometer for this purpose.



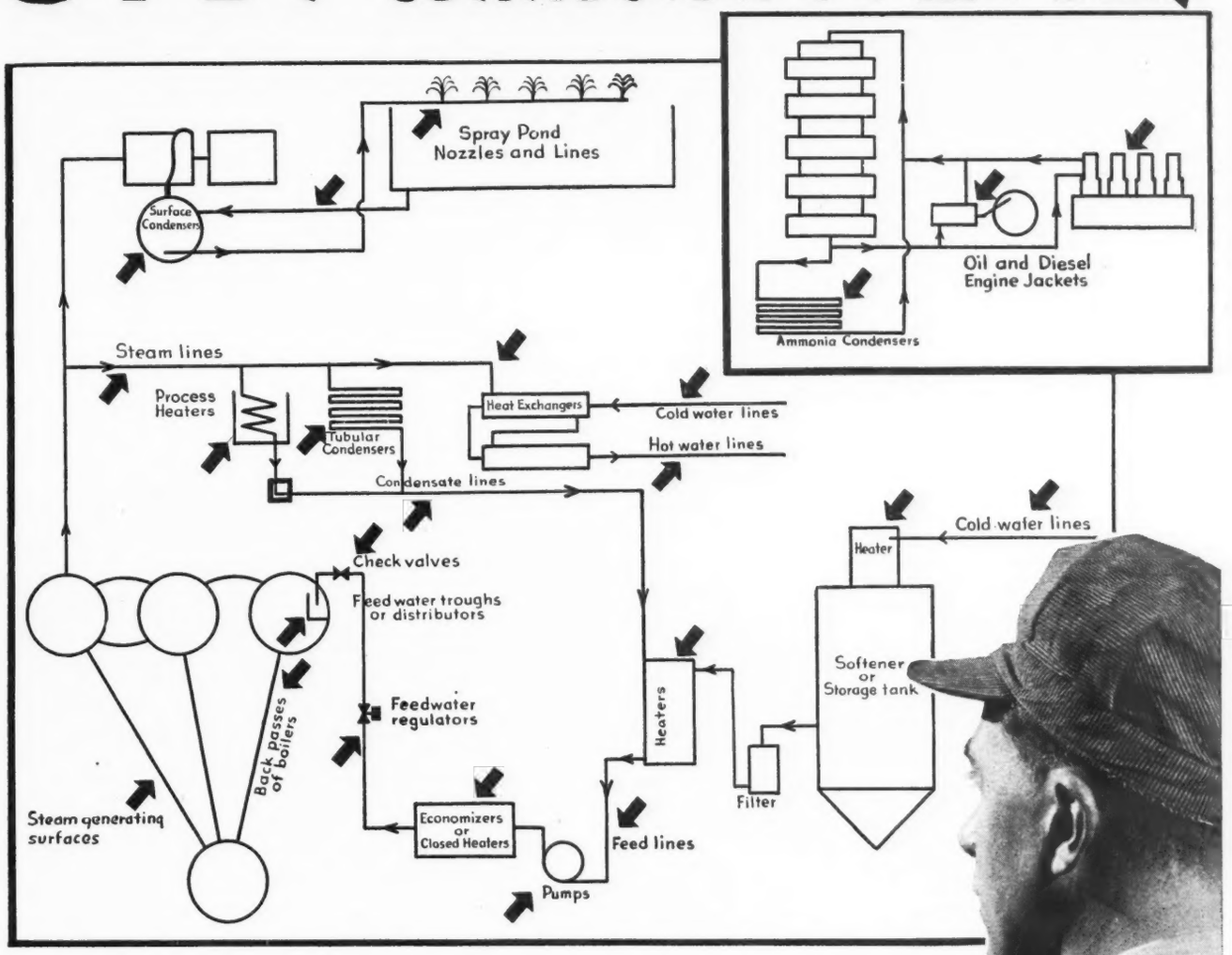
In many cases, water flows into centrifugal pumps under positive pressure from city water mains, constant level tanks or from rivers. In such cases the pressure at the inlet side of the pump can be calculated or obtained from existing gages installed in the line near the pump.

To determine flow, read pressure gage on discharge outlet of pump, add or subtract suction pressure, and find gpm corresponding to head on manufacturer's output curve. Throttling the globe valve below the gage will be found useful in reducing vibration of the pressure-gage hand, making possible more accurate readings.

In order to use this method effectively, pumps must be in good condition. Only pumps which have a decided drooping characteristic, that is, a reasonably high pressure drop with increase in flow, should be tested in this way. Pumps with flat characteristics cannot be checked satisfactorily by this method. A glance at the manufacturer's charts for the pumps under consideration will show whether this system is applicable. Flow should not be measured in this manner if accuracy is desired, but where an error of $\pm$ 10% is allowable, it is sufficiently correct for estimating purposes.

Staunton, Va. B G SWITZER

STOP SCALE AND CORROSION HERE!



YOU know from experience that scale or corrosion, or both, can cause trouble in many places besides your boiler tubes and drums. But what you may not know is that Nalco offers service to prevent such trouble. Many Nalco customers are now taking advantage of this complete service. The advantages are obvious: (1) One responsibility for your entire plant. (2) Low combined cost. (3) Regular, systematic attention given to all of your problems. We will be glad to give you details on this *complete* treating service.

Write. **NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.**

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Current Comment

Who's An Engineer?

IN THE November, 1938, number, "Current Comment," page 96, Mr John Doe asks, "Am I an engineer of any class, rank or degree?" Of course, the answer to this question depends upon our definition of the term Engineer.

Funk and Wagnall's New Standard Dictionary defines it as "One versed in, or practicing, any branch of engineering", and Webster's International says practically the same thing, with somewhat more elaboration, including "One who manages, or runs an engine".

Undoubtedly Mr Doe is justified in calling himself an operating engineer, as he is now legally practicing as such, and if, as he states, he is able to get to the bottom of any steam or combustion problem in connection with his work, he is justified in calling himself a particularly good one.

On the other hand, Mr Doe would hardly be justified in claiming to be qualified in a state requiring a license, unless he already has one, or is prepared to submit satisfactory evidence that he is qualified to receive one. It seems to me, that in the absence of statutory requirements, the entire question is one of common sense, and common honesty. Engineering is a very broad field, and no one can cover more than a small portion of it.

No reader of POWER can pass final judgment upon the qualifications of Mr Doe, solely upon the evidence submitted, although, if we take his statements at face value, we would no doubt conclude that he is a well qualified combustion engineer, and somewhat of an expert in the operation of steam plants.

In most states, a license is required for operating engineers, and in many, there are also licensing laws covering the practice of professional engineering. These laws generally state that no one shall "practice or offer to practice" professional engineering as defined by the statute, unless he is duly licensed.

There are generally certain specified exemptions, and no doubt a number of loopholes, but it is obvious that no attempt at misrepresentation can be justified upon ethical grounds. On the other hand, where the law does not prohibit it, there is apparently no valid reason why Mr Doe, or any one else, should not call himself any kind of an engineer he believes justified by his knowledge and experience.

Bloomfield, N. J. J O G GIBBONS

John Doe's Experience

SOME LITTLE time ago I was away from the plant for a few days, and during my absence, it was decided to operate the plant a day extra that week. There were two hand-fired upright water-tube boilers on the line at the time; operating schedule called for steam practically 24 hr per day, except for the last day of the week's run, which ended at 6 p.m.

On this particular day, a graduate mechanical engineer from a well-known college came down to the boiler room and ordered the firemen to keep steam as usual until 6 p.m., then bank the fires and go home, and finally to return in the morning, break the fires and get up steam.

Anyone can imagine the reaction to such an order, and the discussion that followed. I would rather trust the plant to John Doe than to many of the graduate professional engineers I have met. They know text books, maybe, but not always the plant.

Give me the man with four or six years in the power plant every time rather than one with a diploma under his arm and no experience. The man with the diploma usually thinks he knows it all, instead of realizing that he's just beginning. To me, the John Does are the engineers. They have come up through much trial and tribulation. Their eyes and ears are trained. They usually know their stuff.

Ansonia, Conn. ANOTHER JOHN DOE

The Question is Economic

JOHN DOE is an engineer. He needs no ornately emblazoned diploma or license to attest the fact. The proof is in the record—obstacles overcome, holding a responsible position during the last few years of economic stress, an insatiable curiosity. John Doe and men like him are highly skilled craftsmen endowed with vision and the will to make the most of the work they have. Artists too, lacking the temperament perhaps that comes from exposure to threadbare ghosts in classic halls, but artists just the same, sensitive to any sour note in the symphony of running machinery or a color clash above a fuel bed. Of such a breed came men like Watt and Edison and who shall say they were not engineers.

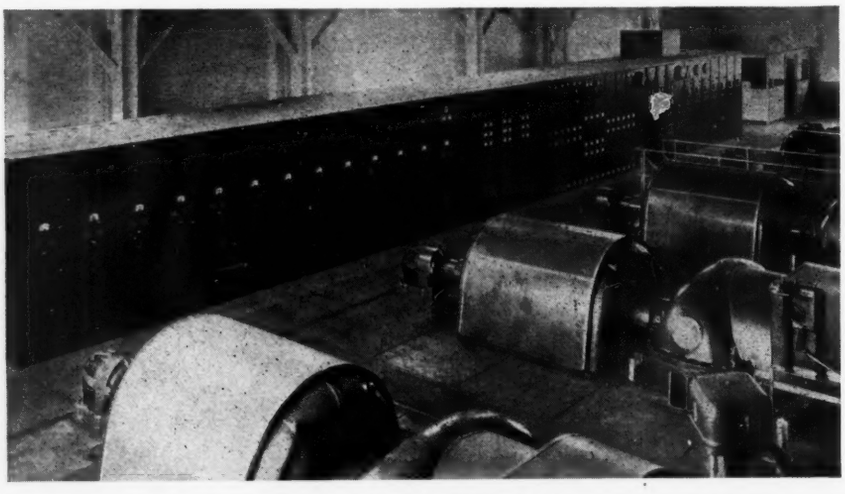
That John Doe is perplexed is natural. Around him in this highly competitive world of ours he sees various groups clamoring for recognition and power. Camouflaged under high-sounding phrases, movements are underway to set up monopolies based on laws defining who shall be and who shall not be entitled to call himself an engineer.

Spawned during periods of business inactivity, such attempts by any one group to benefit themselves financially at the expense of allied groups, if successful, will seriously interfere with advancement of the field as a whole. Why, after all, should one set of engineers, in an effort to protect their investment in a college education, deliberately exclude men who have been forced by circumstances to secure their knowledge the hard way and, from personal experience working with and under men of this type, I sometimes think the best way?

And John Doe is educated. His laboratory training is the finest—the application day after day in an operating plant of the theory picked up from books selected to fit his individual requirements. He may be deficient in higher mathematics but where is the operating problem that cannot be solved with simple arithmetic or algebra? His thirst for knowledge, unquenched after years of practical work, points to the highest type of education, and that will not atrophy as time goes on. Is he to receive no credit for the effort made, the hours of study required, and the cash outlay that was necessary to perfect himself in this knowledge?

True, he has no operating engineer's license. That is beside the point, how-

(*Continued on page* 122)



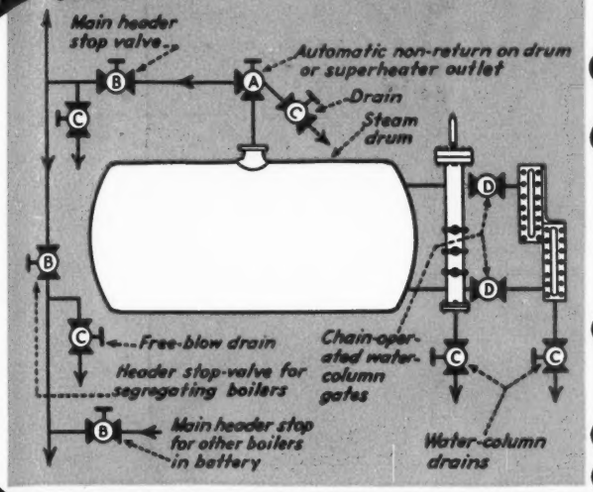
STREAMLINED SWITCHGEAR

38 General Electric switchgear units, shipped assembled and ready to install, in operation on the turbine-room floor of a large rayon plant. The equipment controls three 2400-volt, 2-phase, 60-cycle, and three 3450-volt, 3-phase, 150-cycle generators, with accessories

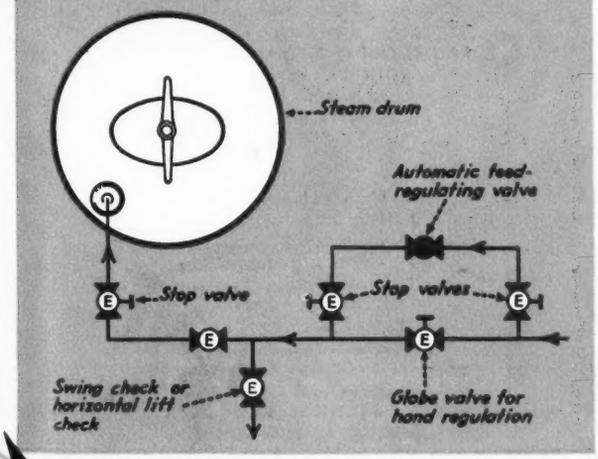
. . . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

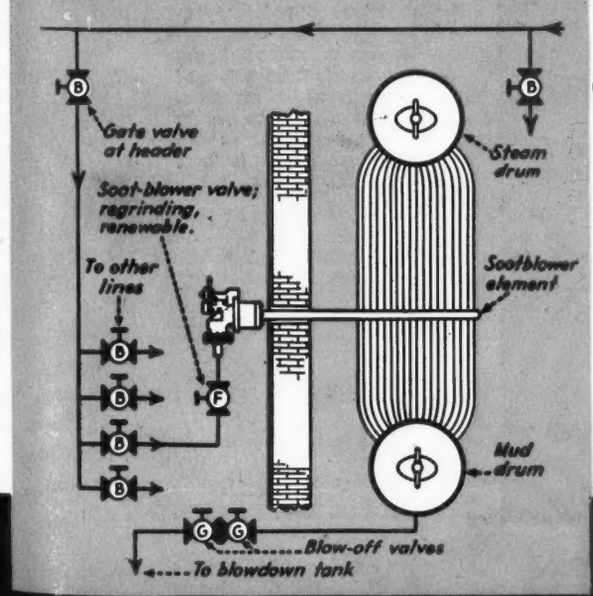
STEAM



FEED WATER



SOOT BLOWER and BLOW DOWN



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B	HEADER GLOBE.....	IRON 142 Fl. Disc Type 913 Fl. Regrinding	IRON 162 Fl. Disc Type 923 Fl. Regrinding STEEL 1042 Fl. 30-Series	STEEL 1042 Fl 30-Series	STEEL 1044 Fl. 40-Series	STEEL 1046 Fl. 60-Series
	ANGLE.....	IRON 144 Fl. Disc Type 915 Fl. Regrinding	IRON 163 Fl Disc Type 925 Fl. Regrinding STEEL 1043 Fl. 30-Series	STEEL 1043 Fl. 30-Series	STEEL 1045 Fl. 40-Series	STEEL 1047 Fl. 60-Series
	GATE.....	IRON 651 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y. STEEL 1010 Fl. 30-Series	STEEL 1010 Fl. 30-Series	STEEL 1011 Fl. 40-Series	STEEL 1012 Fl. 60-Series
C	DRAINS, DRIP GLOBE.....	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Ren.	BRONZE 1140 Sc. Regrinding 1150 Sc. Regr -Ren	BRONZE 970 Sc. Regr.-Ren.		
	ANGLE.....	BRONZE 108A Sc. Disc Type 752 Sc. Regrinding 952 Sc. Regr -Ren.	BRONZE 1141 Sc. Regrinding 1152 Sc. Regr.-Ren.	BRONZE 972 Sc. Regr.-Ren.		
D	WATER COLUMN GATE.....	BRONZE 275 Sc. O.S. & Y.	BRONZE 282 Sc. O.S. & Y.			
E	BOILER FEED STOP & CHECK GLOBE.....	BRONZE 630 Sc. Disc Type 631 Fl. Disc Type	BRONZE 638 Sc. Disc Type 639 Fl. Disc Type	BRONZE 638 Sc. Disc Type 639 Fl. Disc Type STEEL 30-Series	STEEL 40-Series	STEEL 60-Series
	STOP & CHECK ANGLE.....	BRONZE 632 Sc. Disc Type 633 Fl. Disc Type	BRONZE 640 Sc. Disc Type 641 Fl. Disc Type	BRONZE 640 Se. Disc Type 641 Fl. Disc Type STEEL 30-Series	STEEL 40-Series	STEEL 60-Series
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	HORIZONTAL LIFT CHECK..	BRONZE 117A Sc. Disc Type 316A Fl. Disc Type 756 Sc. Regrinding 757 Fl. Regrinding	BRONZE 807 Sc. Disc Type 808 Fl. Disc Type 967 Fl. Regr.-Ren. 995 Fl. Bolt. Cover Regr.-Ren. 263 Sc. Disc Type 966 Sc. Regr.-Ren.	BRONZE 263 Sc. Disc Type 133 Fl. Disc Type 966 Sc. Regr.-Ren. 994 Sc. Bolt. Cover Regr.-Ren. STEEL 30-Series	STEEL 40-Series	STEEL 60 Series
	GLOBE.....	BRONZE 106A Sc. Disc Type 107A Fl. Disc Type 750 Sc. Regrinding 751 Fl. Regrinding 950 Sc. Regr.-Ren. 951 Fl. Regr.-Ren.	BRONZE 801 Sc. Disc Type 802 Fl. Disc Type 971 Fl. Regr.-Ren. 1140 Sc. Regrinding 1150 Sc. Regr.-Ren. 1151 Fl. Regr.-Ren.	BRONZE 970 Sc. Regr.-Ren. 982 Sc. Regr.-Ren. Bolt. Bonn. 983 Fl. Regr.-Ren. Bolt. Bonn. STEEL 1042 Fl. 30-Series	STEEL 1044 Fl. 40-Series	STEEL 1046 Fl. 60-Series
	ANGLE.....	BRONZE 108A Sc. Disc Type 109A Fl. Disc Type 752 Sc. Regrinding 753 Fl. Regrinding 952 Sc. Regr.-Ren. 953 Fl. Regr.-Ren.	BRONZE 803 Sc. Disc Type 804 Fl. Disc Type 973 Fl. Regr.-Ren. 1141 Sc. Regrinding 1152 Sc. Regr.-Ren.	BRONZE 972 Sc. Regr.-Ren. 984 Sc. Bolt. Bonn. Regr.-Ren. 985 Fl. Bolt. Bonn. Regr.-Ren. STEEL 1043 Fl. 30 Series	STEEL 1045 Fl. 40-Series	STEEL 1047 Fl. 60-Series
F	SOOT BLOWER GLOBE.....	BRONZE 956 Sc. Regr.-Ren.	BRONZE 976 Sc. Regr.-Ren. 988 Sc. Regr.-Ren. Bolt. Bonn.	BRONZE 971 Fl. Regr.-Ren. 988 Sc. Regr.-Ren. Bolt. Bonn.		
	ANGLE.....	BRONZE 958 Sc. Regr.-Ren.	BRONZE 978 Sc. Regr.-Ren. 990 Sc. Bolt. Bonn. Regr.-Ren.	BRONZE 978 Sc. Regr.-Ren. 990 Sc. Bolt. Bonn. Regr.-Ren.		
G	BLOW-OFF GATE.....	IRON 650 Sc. O.S. & Y. 651 Fl. O.S. & Y. 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	IRON 204A Sc. O.S. & Y. 204 Fl. O.S. & Y. STEEL 1008 Sc. 30-Series 1010 Fl. 30-Series	STEEL 1008 Sc. 30-Series 1010 Fl. 30-Series	STEEL 1011 Fl. 40-Series	STEEL 1012 Fl. 60-Series
	ANGLE.....	BRONZE 108A Sc. Disc Type 952 Sc. Regr.-Ren. IRON 914 Sc. Regrinding 915 Fl. Regrinding 920 Sc. Regrinding 921 Fl. Regrinding	IRON 924 Sc. Regrinding 925 Fl. Regrinding STEEL 1043 Fl. 30-Series	STEEL 1043 Fl. 30-Series	STEEL 1045 Fl. 40-Series	STEEL 1047 Fl. 60-Series
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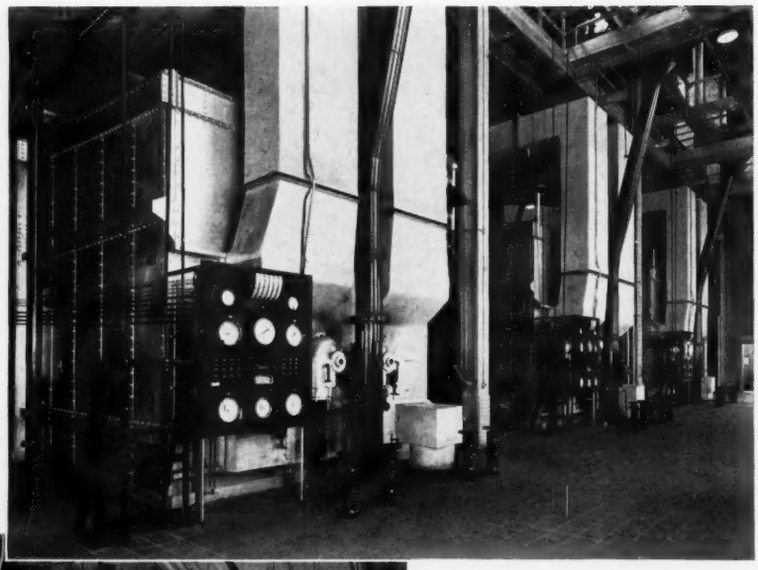

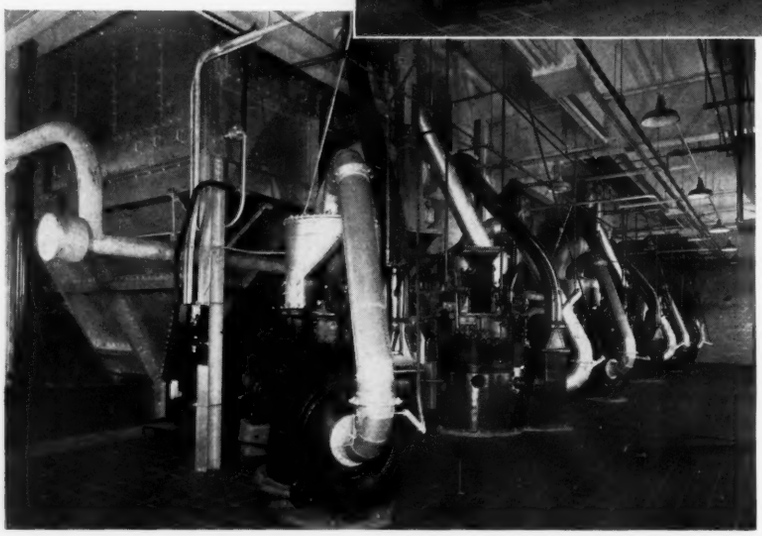

Above—These three pulverized-coal-fired boilers, equipped with completely waterwalled furnaces, superheaters, air heaters, and cyclone separators, each generate, at maximum output, 90,000 lb per hr of 725-lb, 780-F steam

Center—Two pulverizers feed each boiler; one forced-draft and one induced-draft fan handle draft requirements. On one boiler, auxiliaries are motor-driven; on the other two, fans and one of each pair of pulverizers are equipped with dual drives. With one turbine-driven and one motor-driven feed pump, reliability and flexibility are assured

Below—Three 5000-kw, 3600-rpm, condensing-extraction turbine-generators meet heavy power demands efficiently and furnish 15-lb steam for heating and process. Condensers heat circulating water to 105 F, and after treatment, it flows to the mill for process use

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In more than 1000 great industrial plants, in locomotives, ships and other boiler plants, Buromin used under the direction of Hall Laboratories, positively eliminates scale, prevents pitting, embrittlement and carry-over. Year after year, boilers where Buromin is used, stay in steady service without loss of boiler tubes and without shut-downs for tube cleaning.

★ ★ ★

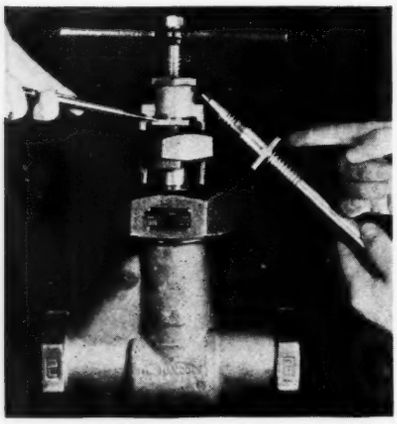
From the water storage reservoir and the coal pile to the throttle we perform a continuous service that safeguards all the equipment involved, and produces a harmony of operation that insures the utmost efficiency with the minimum of maintenance.

HAGAN CORPORATION

Subsidiaries: HALL LABORATORIES, INC · THE BUROMIN COMPANY

300 ROSS STREET, PITTSBURGH, PA.

What's New in Plant Equipment



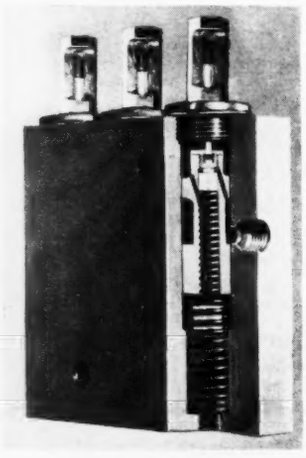
Improved Steel Valves

PRINCIPAL improvement in Hancock forged- and cast-steel valves is new material for renewable stem-thread bushing —Duronze, an aluminum, copper and silicon alloy. Makers claim that with new bushings, valve will operate satisfactorily without lubrication of stem at elevated pressures and temperatures. These bushings are said to have exceptionally low coefficient of friction, very high resistance to wear and corrosion, plus a tensile strength of 90,000 lb.

Hancock Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn.

Lubricating System

MODEL H lubricating system for cranes and auxiliary equipment is a manually operated pumping unit for use with new Model H measuring valve. Pump holds 8 lb of grease and can be filled by hand, or by a portable grease pump through a fitting. Double-acting pistons reduce

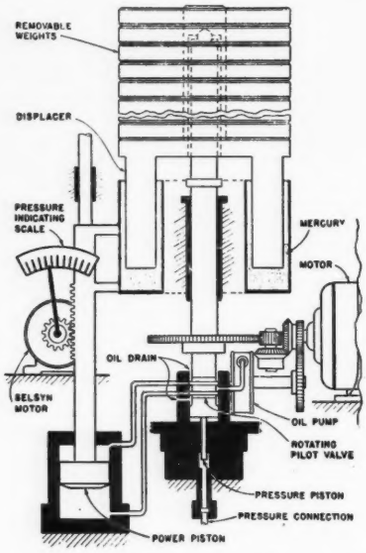


time cycle of operation, and a detachable handle is a safety precaution against tampering or excessive operation. Illustration shows a 3-valve block, cut away to reveal construction of one valve chamber.

Blaw-Knox Co, Gordon Lubricators Div, Pittsburgh, Pa.

Pressure Gage

POWER gage for measuring high pressures is accurate to 0.1% of reading. As shown diagrammatically in illustration, gage provides accurate pressure readings

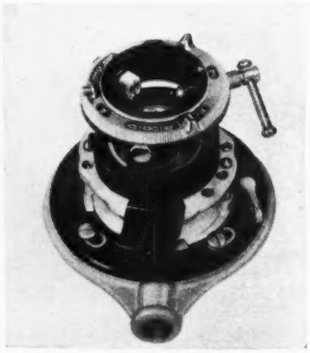


on an indicating scale and can also transmit these readings to indicators and recorders at distant points. One of these gages is designed for a maximum range of 10,000 to 12,000 lb psi.

Bailey Meter Co, Cleveland, Ohio.

Pipe Threaders

"RIGID" No. 65R and 85R series of pipe threaders are made of all steel and malleable alloy, with drop-forged hardened-tool-steel cam plates. These tools thread 4 sizes of pipe—1, 1¼, 1½ and 2 in.—

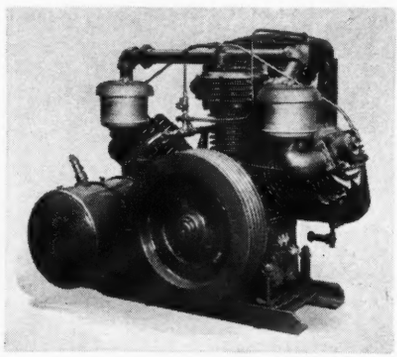


with one set of chaser dies. Only 4 dies, instead of usual 16, made of semi-high-speed tool steel, stay in threader, saving time and trouble for operator. No. 65R illustrated.

Ridge Tool Co, Elyria, Ohio.

Compressor Mounting

PORTABLE air compressor with power take-off drive consists of Worthington

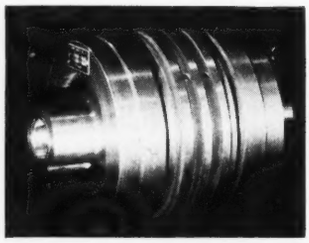


compressor driven through a multi-V drive by a Hercules unit installed between truck transmission and front universal joint of propeller shaft. Compressor is 3-cyl, 2-stage radial air-cooled type on standard portable mounting, and includes improved feather valve, ring-type fins, large sectional intercooler, force-feed lubrication, and bypass unloading. Bulletin H-850-B55.

Worthington Pump & Machinery Corp, Harrison, N. J.

Magnetic Clutch

TYPE ED multiple-disk magnetic clutch is designed to operate as two clutches, both magnetically energized by single magnet. By a duplex arrangement, the unit can be operated in either direction simultaneously. To conserve space, col-

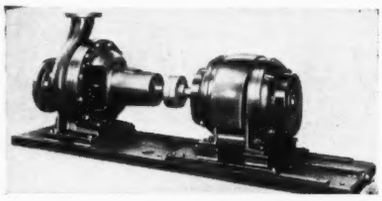


lector rings are carried on outside diameter, one collector ring being common to both magnetic coils. This provides simplicity and efficient electrical feed plus minimum possibility of trouble with contacting elements.

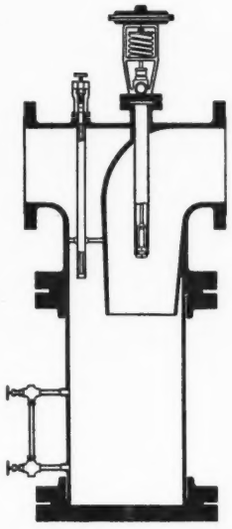
Stearns Magnetic Mfg Co, Milwaukee.

Centrifugal Pump

TYPE PO single-suction, open-vane-impeller centrifugal pump is much like Type SSOR open-runner pump. In addition, new pump is designed so that its rotating element can be readily withdrawn



The COPES DESUPERHEATER



Accurate for total or partial desuperheating, on steam from 212 to 1100 degrees F.

Dependable for all flows, regardless of any change in the temperature of the superheated steam entering the unit.

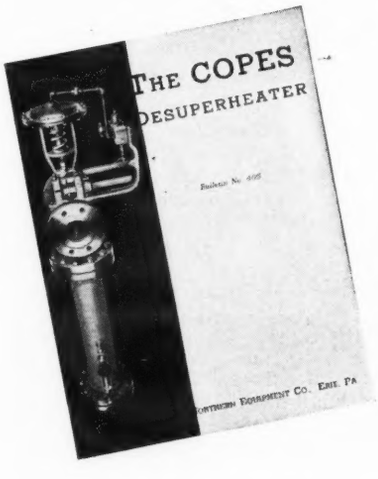
Water correctly proportioned to steam at all times because cooling water is controlled at the spray nozzle—not by any outside control valve.

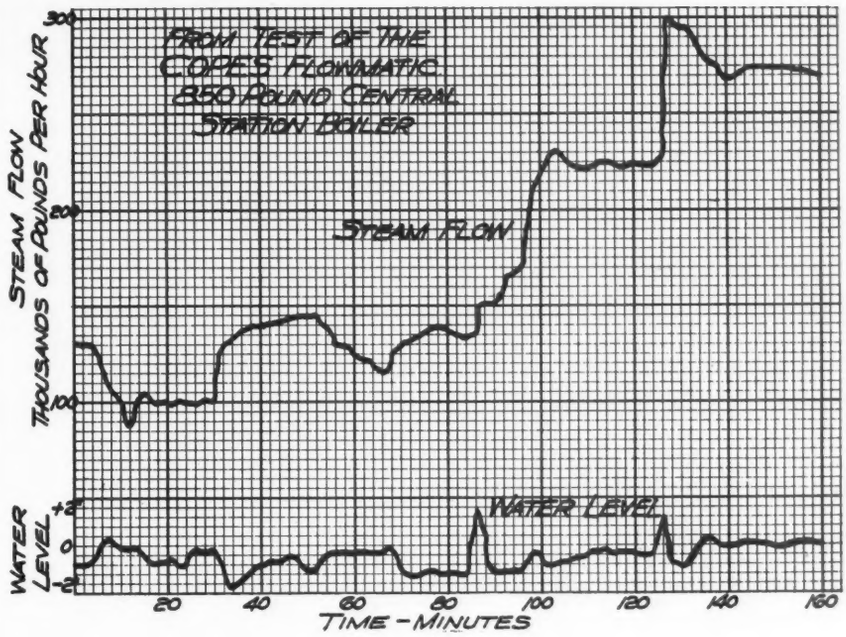
Final temperature held within close limits, because cooling water is completely atomized.

A self-contained unit, with a simple external adjustment for temperatures and sensitivity.

For complete information—

Write for Bulletin 405





Troubled with Carry-Over?

No matter how rapid your load swings, the COPES Flowmatic Regulator will hold your boiler water level within close, safe limits. This will greatly reduce the possibility of water carry-over, and thus help you avoid excessive maintenance on superheaters and prime movers. For the COPES Flowmatic is easily adjusted—no "experts" needed—to give you exactly the right water level characteristic for safest, most economical operation of your boilers. Write—on your letterhead—for descriptive Bulletin 409-B.

NORTHERN EQUIPMENT CO., 111 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

Get closer level control with the

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

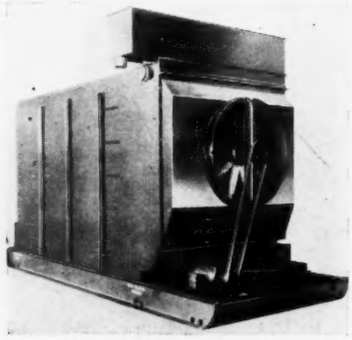
★ REGULATOR

from casing without disturbing suction- and discharge-piping connections, or alignment of pump and motor which are mounted on a common base. Bulletin No. 2293.

Allis-Chalmers Mfg Co, Milwaukee, Wis.

Water-Cooling Unit

PORTABLE cooling unit for cooling jacket water of internal-combustion engines used for oil-field drilling and pumping. Only two connections to jacket-water system: inlet and outlet. Large raw-water tank stores more than enough water to feed cooling system at all



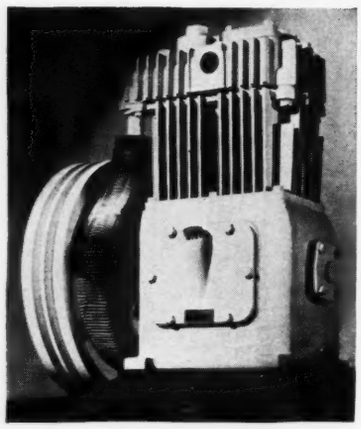
times. Copper atmospheric tube sections easily accessible so that both exterior and interior surfaces can be cleaned when necessary. Raw-water pump driven by ac or dc motor, gas or gasoline engine, as desired.

The Marley Co, Fairfax and Marley Rds, Kansas City, Kan.

Pneumatic Spreader Stoker

DUAL air spreader stoker has two pneumatic conveying systems attached either to a single hopper or to a bin outlet. Fines burn in suspension, as with powdered coal burner; larger pieces fall on grates and burn in a shallow layer, as with conventional overfeed stoker. Streams of high-velocity air convey and spread steam-size coal, which is said to give a high degree of turbulence and prevent stratification. May be fired by hand in case of emergency; made in sizes with capacities up to 3200 lb of coal per hr.

Iron Fireman Mfg Co, Portland, Ore.



Air Compressors

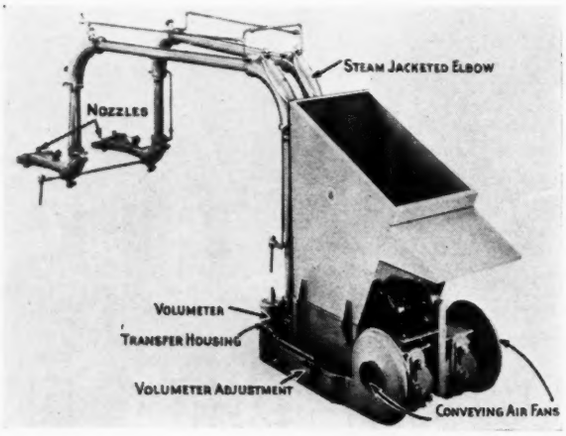
LINE of improved air compressors has these refinements: increased over-all efficiency, 12% greater radiation area on cylinders, more thorough and positive constant-level oiling system, dust-proof crankcase, and non-breakable, cushioned discharge valves that are said to make operation smoother and quieter. When furnished for automatic stop and start operation, a loadless starting device automatically withholds all load from motor until it reaches full speed. Sizes range from 2.8- to 30.1-cu-ft-per-min piston displacement. Single-stage—single-cylinder, single-stage—duplex cylinders, and 2-stage models are available in a wide variety of mountings.

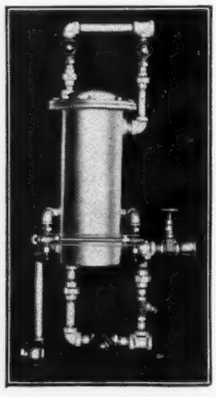
Quincy Compressor Co, Quincy, Ill.

Rust Preventative

THIS system claimed to prevent rust, corrosion and congestion in steam mains, both high and low pressure, for heating and process. A specially developed product vaporizes and atomizes when introduced into steam main by equipment shown in illustration. Equipment consists of housing containing a copper coil, valves through which rust-preventative is introduced, a gage to show amount held in housing, and necessary connections for steam inlet, steam outlet and trap return. Mogul Pressure-Jet is name of equipment, and Mogul Rust Eradicator, name of material.

North American Fibre Products Co, 1612-20 Keith Bldg, Cleveland, O.





Electric Hoist

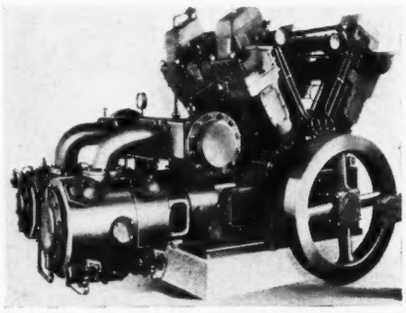
PRINCIPAL new development of "Cable King" electric hoist is air cooling. Fins, simulating a Sirocco blower, are cast in brake drum in line of air stream. As load is lowered, fins revolve to produce air circulation and cooling action that forces a constant flow of cool air around brake and gear housing. Tests per-

formed by the manufacturer show that air cooling, as applied in the design of this hoist, provides a hoist that will perform on heavier duty cycle than other hoists in the same class. Either ac or dc; capacities from ¼ to 6 tons.

Yale & Towne Mfg Co, Philadelphia.

Diesel-Driven Compressor

TYPE XVO heavy-duty, diesel-driven compressor combines a horizontal double-acting compressor with heavy-duty, V-type, 4-cycle diesel in a compact unit that operates at moderate speed. Sizes are available for actual-free-air-delivery ratings of 625, 935 and 1250 cfm for 100-

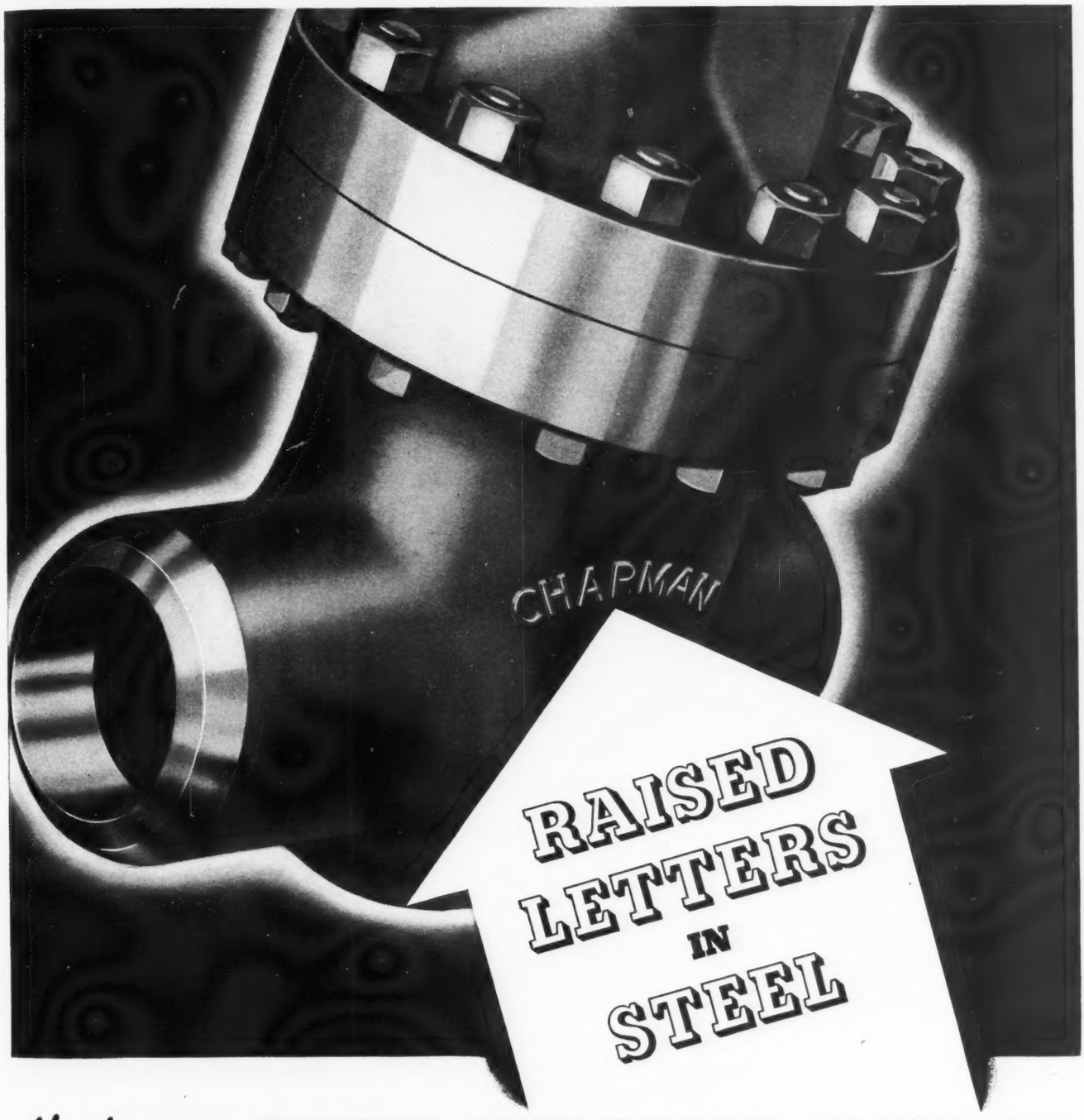


lb sea-level compression. Also, wide variety of air-, gas- and ammonia- compressing cylinders is available for pressures from vacuum to 5000 lb psi and higher. Bulletin 3072.

Ingersoll-Rand Co, 11 Broadway, New York, N. Y.

Bearing Seal

TRIPLE seal, for protecting bearings against lubricant leakage, dust dirt, etc, consists of two split rings on each side of housing and grooved on outside diam-



that mean RAISED STANDARDS IN VALVES

The name of Chapman on the body of a valve is a steel-clad guarantee of outstanding performance on the highest-rating power plant service. Specify Chapman Power Plant Valves. Gate, globe, check and angle valves. Valves for temperatures up to 1000°F. and pressures to 2500 lbs.

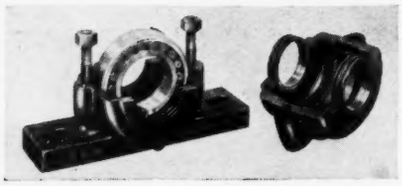
MADE IN THESE ALLOYS

Carbon Steel—Carbon Molybdenum Steel—Chrome Nickel Steel—Nickel Steel—Chrome Molybdenum Steel—Chrome Tungsten Steel—Chrome Nickel Tungsten Steel.

WRITE FOR CATALOG

THE CHAPMAN VALVE MFG. CO., INDIAN ORCHARD, MASSACHUSETTS

CHAPMAN POWER PLANT VALVES

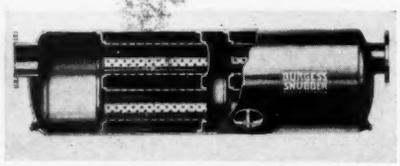


eter to form a labyrinth seal with two end bores of housing. Each ring has inward tension that enables it to turn with shaft. On either side of housing, two rings are mounted in shaft with the splits 180 deg apart to prevent lubricant leakage through splits. Inner ring serves as internal flinger, and outer rings keeps dirt and other foreign matter from entering housing. Made for complete range of standard shaft sizes.

SKF Industries, Inc, Front St and Erie Ave, Philadelphia, Pa.

Exhaust Silencer

"EXHAUST SNUBBER", for internal-combustion engines, was recently tested on a 1-cyl engine. Results are said to be: pressure peaks at engine were reduced from 5 to 1¾ lb; there was no free oscillation of the column of exhaust gas; exhaust sound was a soft puff and there were no further impacts to cause sustained tonal sound. As Snubber elimi-

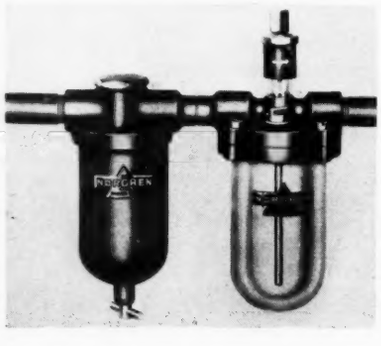


nates pressure waves in exhaust system, resonant conditions are never set up. Thus, it is possible to place Snubber at any point in system and to use exhaust-pipe length dictated only by architectural considerations. Also, device is claimed to be as effective on multi-cylinder engines as on single-cylinder units.

Burgess Battery Co, Acoustic Div, Chicago, Ill.

Air-Line Lubricator and Strainer

A COMBINATION of two devices, air strainer and sight-feed lubricator, is designed to condition air for air tools. Strainer consists of double screen, bronze head, and drawn-steel tin-dipped bowl. A 200-mesh Monel screen is supported by a 100-mesh brass screen. Lubricator follows in general patented design of standard Norgren lubricators, with added feature of transparent oil reservoir of resilient plastic, which, it is claimed, will not chip, stain or shatter. Made in ¼-, ⅜- and ½-in. sizes for horizontal lines.



C A Norgren Co, Inc, Denver, Colo.

Temperature-Pressure Recorder

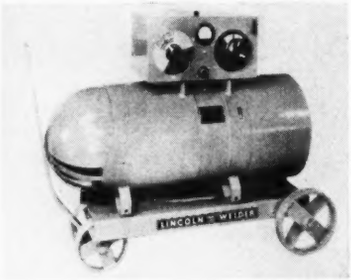
IMPROVEMENTS of temperature and pressure recorder with 9-in. chart are: interchangeable tube system that can be replaced readily and that need be checked at one temperature only; pen-arm bracket supported by bearings at both ends;

positive micrometer pen adjustment; convenient chart holders—turn of knurled knob releases gripping fingers and chart slips over. Bulletin No. 1178.

C J Tagliabue Mfg Co, Park and Nostrand Aves, Brooklyn, N. Y.

Arc Welder

LINE of "Shield-Arc" welders has both job selector and current control calibrated and equipped with dials that indicate type of work and number of amps for each setting. It is claimed that this development enables operator to secure highest-quality welds and high speeds because he can vary both slope of volt-

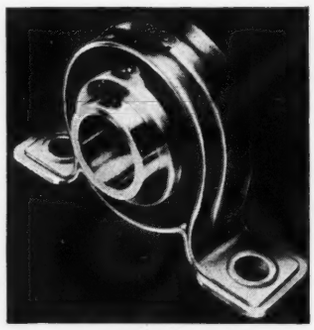


ampere curve and amount of welding current, independently and positively to suit every job. Another feature is that both voltage control (job selector) and current control are continuous in operation, which provides thousands of possible combinations of voltage and current.

Lincoln Electric Co, 12812 Coit Rd, Cleveland, Ohio.

Pillow Block

"RUBBER FLEX" pillow block comprises a self-locking bearing that is inherently aligning, thus compensating for inaccuracies of set-up and conditions of shaft misalignment without binding. Bearing



is encased in pressed-steel housing equipped with felt seals to exclude dirt. Bearing and housing are surrounded with elastic material having sound-absorbing characteristics, and material has been specially treated to make it impervious to oil and grease. ¾- and 1-in. sizes.

SKF Industries, Inc, Front St and Erie Ave, Philadelphia, Pa.

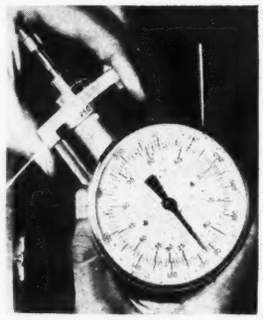
Condensation Pump

SMALL, combined condensation pump and receiver, for heating systems where there is a small amount of direct radiation, can be used for 500 to 2000 sq ft direct radiation and 10 to 45 lb pressure. Motor, vertically mounted on top of receiver, is single-phase, 110/220-volt, 60-cycle, 1750-rpm repulsion-induction unit. Pump is suspended in receiver from motor.

Chicago Pump Co, 2334 Wolfram St, Chicago, Ill.

Hand Tachometer

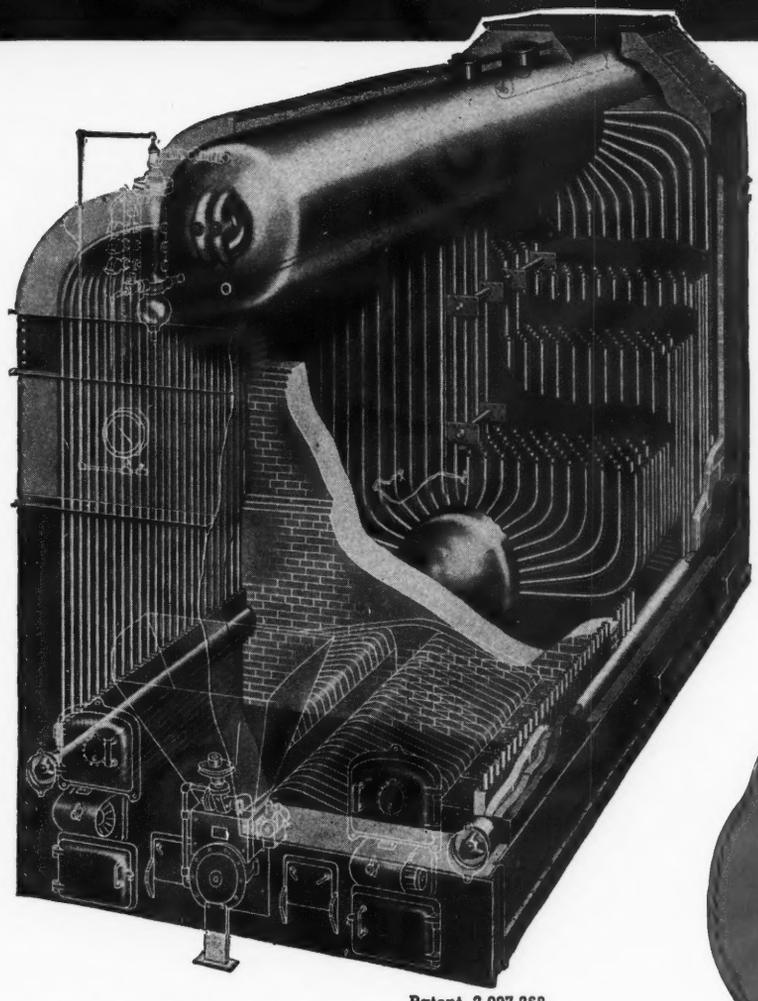
MODEL S & S jewelled hand tachometer measures any speed from 25 to 30,000 rpm in three ranges. Operates on centrifugal or flyball-governor principle. Pointer turns twice around dial, with readings obtained from two sets of nu-



merals, one for inside scale graduation other for the outside. For example, for measuring from 25 to 300 rpm, hand must be watched as it goes around dial. After hand reaches number 100 at foot of dial on inside scale, rpm is thereafter indicated by outside scale.

George Scherr Co, 128 Lafayette St, New York, N. Y.

TYPE CP STEAM GENERATOR

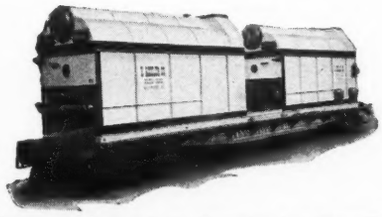


Patent 2,097,268

Over two hundred "CP" installations are paying for themselves out of fuel savings. One user writes: "It is apparent that the installation will pay for itself in approximately two years."

THE CULMINATION OF 75 YEARS OF BUILDING BETTER BOILERS

75 YEARS OF CONTINUOUS SERVICE TO INDUSTRY
75TH. ANNIVERSARY
E. KEELER CO.
WILLIAMSPORT PENNA.
1864-1939



Also manufactured in Canada by Canadian Vickers, Limited, Montreal, Canada.

The survival of an industry over a period of years is determined by the measure of its service.

Seventy five years of technical advance, a quality product, backed by financial responsibility and fair dealing has been the justification for our continued existence. For three generations the observance of these traditions has been the measure of its success.

COUPON WILL BRING YOU COMPLETE DATA ON TYPE CP

E. KEELER COMPANY

BUILDERS OF BETTER BOILERS — WILLIAMSPORT, PA.

NAME .....

ADDRESS .....

CITY ..... STATE .....

The Right Club . . .

IN THE old days of golf, an ordinary dub finally got to within a hundred yards of the second hole. He turned to his caddy and asked, "What club do I use now?" "Your mashie," instructed the bag carrier. "Nope," said the dub, "I think my midiron is better."

He used it, and sunk the shot. He turned again to the caddy with, "Well, what do you think now?" But the caddy stuck to his guns, "I still think you shoulda used a mashie!"

There's a right and a wrong tool, a right and a wrong way, for any job. The engineer who uses a monkey wrench on a polished nut can probably do the job, but he's almost certain to mess up the nut, and may mess himself up if the wrench slips. His proper tool is an open-end or a socket wrench. He can use the same monkey wrench as a hammer too, in a pinch, but I don't think he'll insist it's the right tool for the job.

The same reasoning applies to equipment. Sure! You can "get by" with the wrong turbine or the wrong pump for years—but eventually it's going to cost you real money to keep it running. As an emergency measure, almost anything will do.

More serious than any of these, though, is using the wrong idea. I've known engineers who bragged about the long working life of an electric light bulb, not believing until they tested it that it cost more a month for current than they'd spend for a newer—and more economical—bulb. I've known 'em too to decide on a certain way of feedwater heating—with live steam, for example—and nothing anybody could say would swing 'em over.

It's an old problem—this business of the right tool. A man can be excused for making a bull on an experiment, but when it's proved practice, he ought at least to listen to reason. After all, dollars off the profits eventually mean dollars off his own pay check.

George Edwards

Engineer

CHAINED..

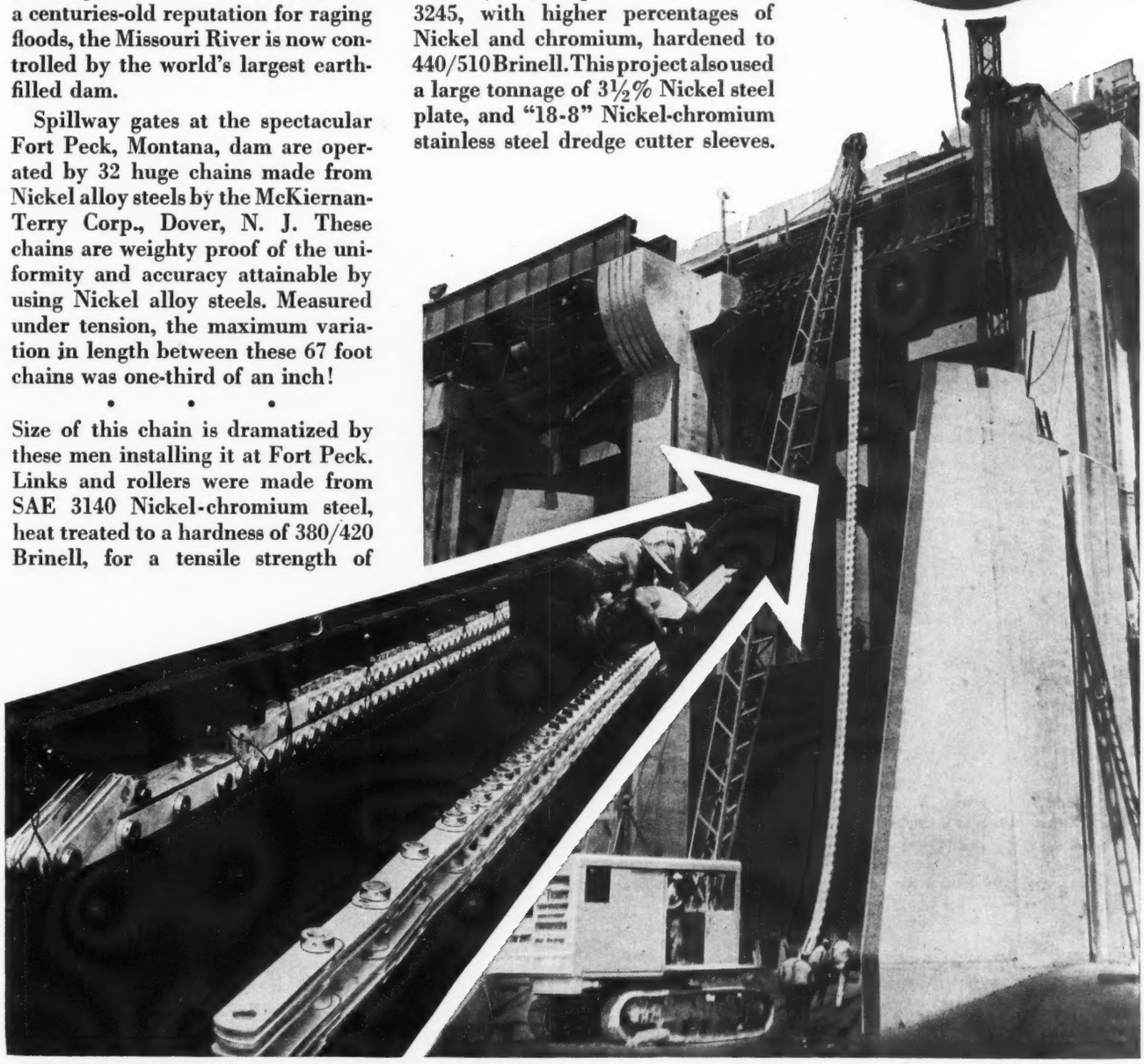
..THE RAGING MISSOURI by ALLOY NICKEL STEELS

Rushing down from the Rockies, with a centuries-old reputation for raging floods, the Missouri River is now controlled by the world's largest earth-filled dam.

Spillway gates at the spectacular Fort Peck, Montana, dam are operated by 32 huge chains made from Nickel alloy steels by the McKiernan-Terry Corp., Dover, N. J. These chains are weighty proof of the uniformity and accuracy attainable by using Nickel alloy steels. Measured under tension, the maximum variation in length between these 67 foot chains was one-third of an inch!

• • •

Size of this chain is dramatized by these men installing it at Fort Peck. Links and rollers were made from SAE 3140 Nickel-chromium steel, heat treated to a hardness of 380/420 Brinell, for a tensile strength of 180,000/200,000 p.s.i. Pins are SAE 3245, with higher percentages of Nickel and chromium, hardened to 440/510 Brinell. This project also used a large tonnage of 3½% Nickel steel plate, and "18-8" Nickel-chromium stainless steel dredge cutter sleeves.



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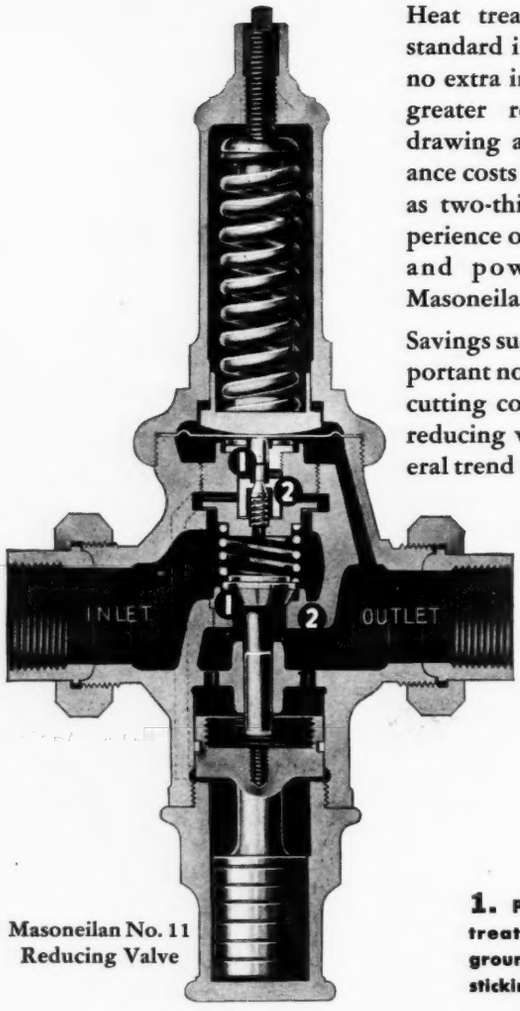

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Heat treated stainless steel trim is standard in these reducing valves—at no extra initial cost. And because of greater resistance to erosion, wire drawing and steam cutting, maintenance costs have been reduced as much as two-thirds, according to the experience of the thousands of industrial and power plants using these Masoneilan No. 11 Reducing Valves.

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Current Comment

(*Continued from page* 108)

ever, as a man of his ability would have no trouble meeting the requirements and passing the usually perfunctory examination in any state where such a license was needed. John Doe's fight can be characterized as a civil war between members of the same profession and such wars always hurt rather than help both belligerents. Would it not be better to present a combined front to the general public and secure a general betterment of evils by educating the public with pointed publicity? What we all need is expressed by Rudyard Kipling's dour Scotch ship's engineer who after complaining of the low regard held for his job by the public, said in effect, "Oh, send a man like Rabbie Burns to sing the Song O' Steam."

Roanoke, Va. S H COLEMAN

Byproduct Power

WE HAVE HAD in our office for some time a booklet sent us by Orrok, Myers and Shoudy, consulting engineers, which included an article written by David Moffat Myers for COMBUSTION, March, 1932. This article was headed, "High-Pressure Steam and Byproduct Power".

We were particularly interested to note Mr Myers' reference on the second page of this article to the percentage of heat left in exhaust and also the percentage used for byproduct power; namely, 90 and 10% respectively. This particularly in view of the criticism of Mr W W Gaylord, Hamden, Conn., in the "Current Comment" section of August, 1938, POWER, where he states that he thinks the amount of heat to be charged to byproduct power should be about 20%.

Troy, Pa. F J VONACHEN

Aligning Line Shafting

TWO DISTINCTLY different viewpoints were expressed in October POWER on aligning line shafting. One theory involves removing all belts and strains from the shaft before proceeding; the other recommends leaving belts and strains on the shaft. The following thoughts may be added to those already presented: when the line shafting is not in operation but the belts all in position, the only belt strain on the line shaft is that which results from normal belt tension or weight of the belt itself, while with the shaft in motion, tension may be considerably more than tension when the belt is at rest.

Without question, it is much easier to align line shafting with belt strains removed, but, personally, I prefer to do the work with all belts in place. This method permits a check for shafting deflection which might indicate that the shaft was too small in diameter for the belt strains or that the shaft was

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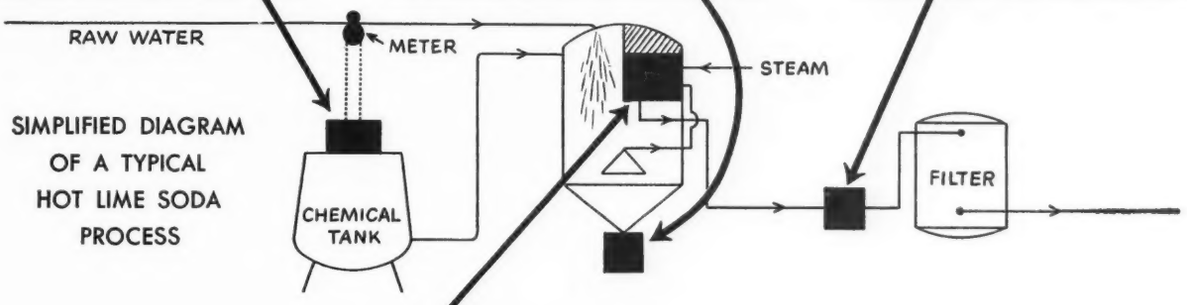
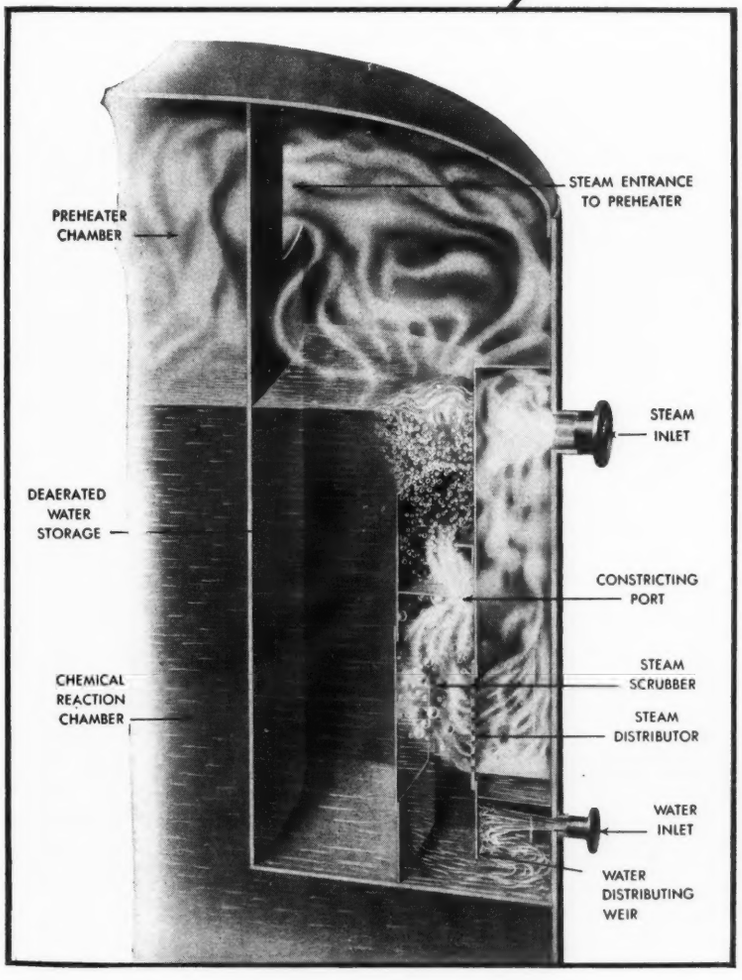


SIMPLIFIED DIAGRAM OF A TYPICAL HOT LIME SODA PROCESS



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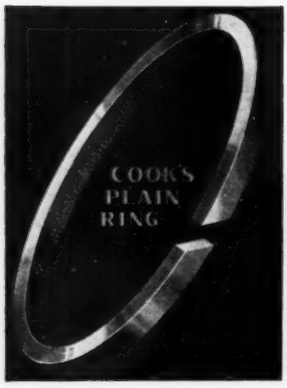

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Piston Rings

insufficiently supported, requiring extra hangers at points of heavy strain. I use a transit, with a target suspended from the shaft. The ideal target has self-centering jaws and can be used throughout the full length of the shaft regardless of variations in shaft size. Belts do not need to be removed, since the target hangs below the average point where belts would interfere.

Hartford, Conn. H W BENTON

What Happened?

THE TROUBLE described in September POWER under the heading "What Happened" was obviously a case of a blowdown valve closed against an accumulation of scale. The valve was thereby gradually cut out, increasing leakage during the period when the superheat was rising. This may have overloaded the feed-heating system, and aggravated the condition.

The steam-flow chart bears out this contention, as the boilers were blown down just before the trouble started and when it ended. Coal may not have been increased because the flowmeter would naturally read high when superheat rose.

Roanoke, Va. S H COLEMAN

WITH DUE regard to the sincerity of all concerned, one cannot help but raise the following doubts: (1) did the operators actually observe the rise in temperature and try to find out what was happening, or was the rise in temperature noted the next morning when the chart was changed? (2) Did the operators recognize abnormal conditions when they were present? (3) Did the operators, knowing of an unusual condition, withhold the information?

(4) Did the operators, knowingly or unknowingly, do something to cause the mystery and not being able to correlate cause and effect, not consider it relevant? (5) Did the supervisory personnel make any effort to retrace movements and actions of operators during or before the time of occurrence?

It can be demonstrated that neither delayed combustion or burning of fly-ash on the horizontal baffle below the superheater will account for the temperature rise. Decreasing moisture content of steam entering superheater might cause the trouble, and cases are on record where superheat has been raised 50 to 75 F. In this case, the steam would have to contain 8-10% moisture in normal operation, and from some unknown cause this would have to be decreased to a point where there was no moisture at all, if final steam temperature were to be raised by 150 F. Such a condition would be highly improbable.

Three temperature charts are shown: No. 1 gives temperature at superheater outlet of 170-lb boiler, No. 3 gives temperature of steam from the 600-lb boiler after it has passed the reducing valve and desuperheater, and No. 2 gives temperature in the 170-lb header. Since no

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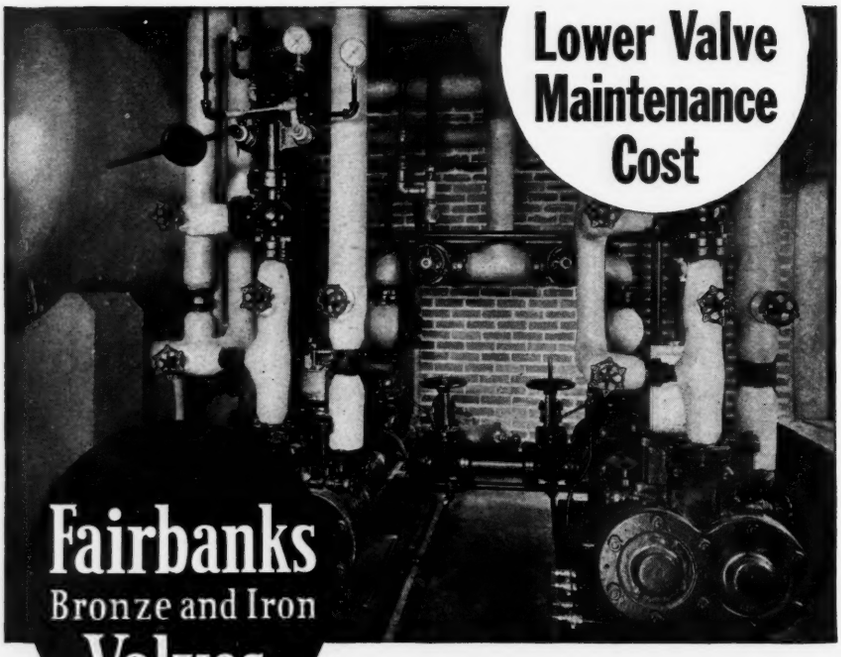

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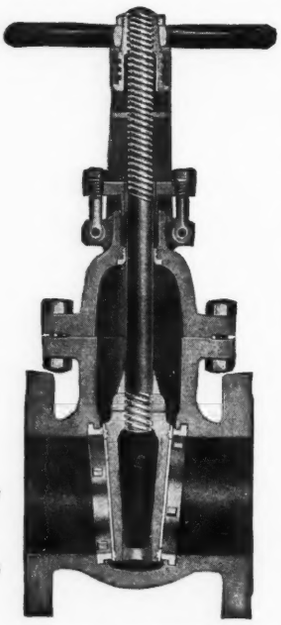

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flow diagram or explanation regarding steam flow is given, there arises the question as to whether the steam in this header is entirely from the 170-lb boiler or partly from the 170-lb unit and the rest from the 600-lb boiler after passing through the reducer and desuperheater. Also, what is the location of the thermometer with respect to steam flow in the header? If steam flowing past No. 2 thermometer is made up of an equal amount from each boiler, it would be reasonable to expect that the temperature would be the mean of that shown by Nos. 1 and 3, or 510 F.

What seems the most plausible explanation of the mystery is this: in a large plant, all gages, meters and thermometers are mounted on a central control board. As indicated by the even divisions on the chart, the thermometers are gas actuated. These instruments have a bulb inserted in the pipeline, a Bourdon tube in the instrument and a capillary tube connecting bulb and Bourdon tube. The capillary tube may be any length up to 200 ft, and may be installed in conduit or just hung up; usually the tube is longer than is actually needed and surplus is coiled up at any convenient point.

In this type of instrument (described in POWER, November, 1937) the capillary tube and Bourdon spring act as an auxiliary bulb and will introduce a line error for changes in line temperature. Thus it would be reasonable to believe that if the capillary tubes of thermometers Nos. 1 and 2 were exposed to a source of heat, there would result an error in their readings. The source of heat could be a stream of hot water or steam, or the tubing may have come in contact with an electric circuit and temporarily have become a conductor. Only an actual inspection would check the possibility of the tubing having been exposed to a higher than normal temperature, thus transmitting to the instrument an erroneous reading.

Rochester, N. Y. JULIUS BRODSKY

Boiler Inspectors

THE COMMENT, "Scale Removal or Safe Ending," by Mr Rudbeck in September POWER brings to mind some experiences I have had with boiler inspectors.

I was in my late twenties when I received my first chief's job and naturally had much to learn. I was very anxious to make good and worked long hours to improve operating conditions and increase plant efficiency.

The boiler inspector who called upon us was a large, domineering sort of man who seemed to take keen delight in abusing me. No sooner had he arrived than he would begin berating me about everything in general. Nothing was ever right and I dreaded the inspection period more each time it arrived. I finally mentioned him to our supervising engineer, who gave me to understand that I did not have to take any abuse from the inspector. Accordingly upon his next visit when he started his

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usual harangue, I took exception to it, threatening to report him to his company if he did not change his ways. Thereafter he was the most courteous of inspectors. Although his disposition was not what it could have been, he was nevertheless a very careful and painstaking inspector.

The opposite held true, however, several years later when I took charge of a power plant in the Middle West. As soon as the opportunity afforded itself I entered the boilers for inspection and found in each case that several of the diagonal braces were badly corroded. In fact, eleven braces had less than one-half of their original cross-sectional area remaining. Upon perusing the boiler inspection reports for two years prior to my taking charge, I found that each one specifically stated that there were no signs of pitting or corrosion. Over a period of twenty years in the operation of steam plants, this, however, is the only case of negligence on the part of an inspector of which I have been cognizant.

St. Paul, Minn. E R WEBBER

Simplex, Duplex, Complex?

[*Editor's Note: One of the answers received to the question in July* POWER *on operating a duplex pump with one side disabled looked unworkable to the editors, so it was returned to the reader with a request for further explanation. The answer printed below bears the stamp of ultimate authority—the method has been tried and proved satisfactory.*]

I RECALL one time when a high-pressure piston of a tandem-compound duplex came loose on the rod, broke as the low-pressure piston drove it against the head with the end of the rod, and cracked the head, putting that side of the pump out of commission.

At first, operators experimented by shifting the valve manually, then tried the finger-type valve gear used on the Hooker simplex. Since the undamaged side had the short arm, connection of the two arm shafts was rejected in favor of a bar fastened to and opposing the crosshead arm of the operating side. Movement was transmitted from the bar to the valve rod by a free-swinging link, one end of which worked up and down in a slotted bar fastened to the valve rod.

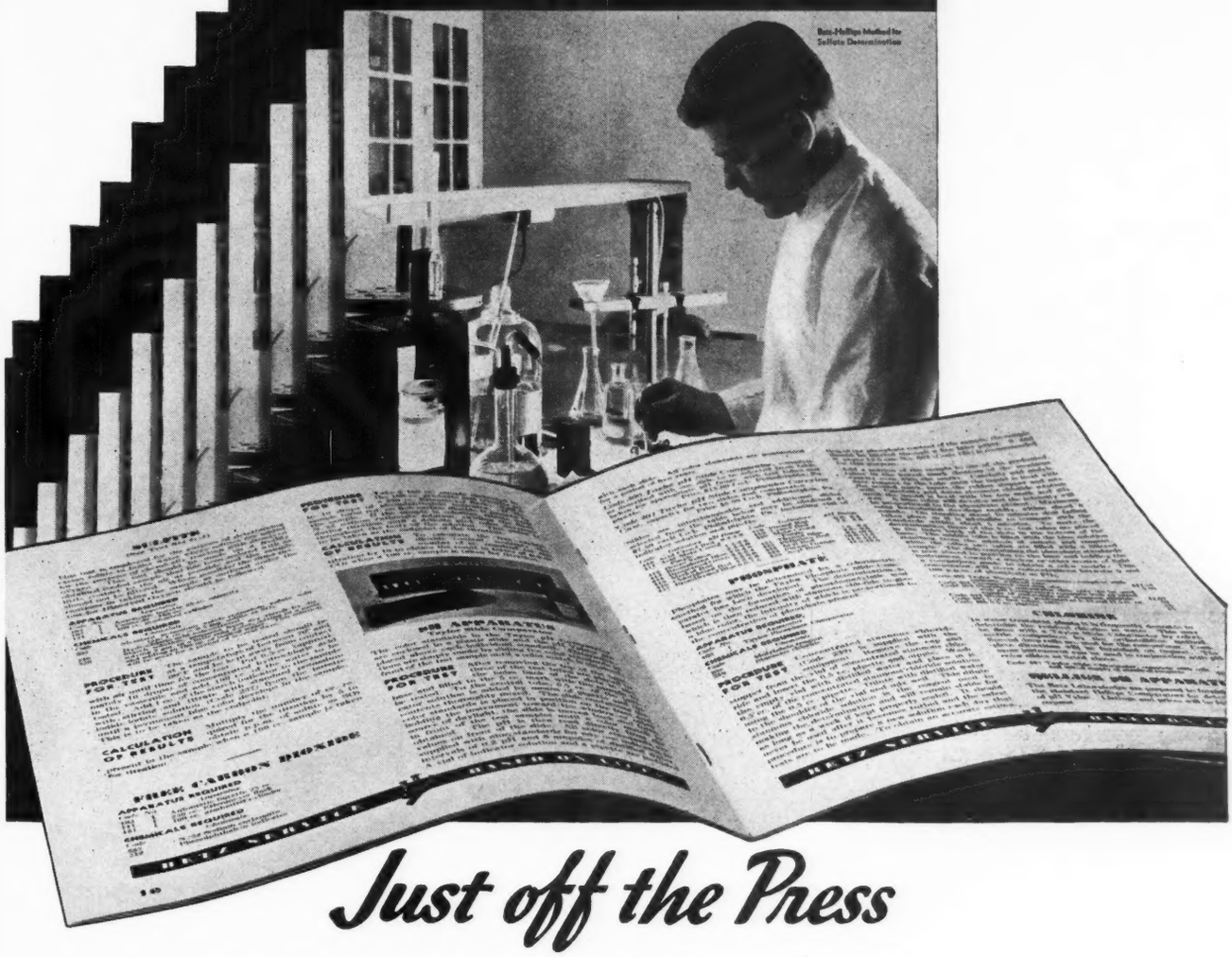
In order to prevent equal port division, resultant equalization of pressure on both sides of the piston, and possible blow-through to exhaust before the valve movement has been completed, valve movement must be rapid and positive once it starts. Other means of securing valve movement than those I have mentioned may be devised, such as a spring kickback which will shift the valve only after the piston has reached its extreme point of travel. Certainly other means of making one side of a duplex run simplex would suggest themselves to me if necessity demanded it.

Marissa, Ill. GEORGE BLUM

Ask for Your Copy

WATER ANALYSIS

Methods • Chemicals • Apparatus



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Readers' Problems

(*Continued from page* 98)

tions, the valve is from 3 to 10 ft. under water.

After some months of trouble-free service, water hammer developed without warning, splitting a 2-in. galvanized pipe. To eliminate the trouble, we installed an air chamber which did not help at all. Then we installed a perforated discharge pipe to avoid agitation of the surface water which, as far as results were concerned, was just so much wasted labor and material. We then did what should have been done in the first place, drained the pit and checked the automatic valve. This was apparently in good condition. Nevertheless, we cleaned it, put new packing in the stuffing box, installed it without the perforated pipe and our trouble was over, even after we removed the air chamber, as this was very much in the way.

Since the trouble reoccurred every five or six months, we transferred the valve from the bottom to the top of the pit where it is readily accessible and always under observation. We found the cause of the trouble always in the stuffing box which was either too loose or too tight.

To overcome FJG's difficulty, I would recommend (1) installation of a valve best suited for the service. A balanced valve with V-shaped ports is good, but, in my opinion, a single-seated valve with dashpot and pilot is better. (2) the water should be discharged well below the low-water level to avoid violent agitation of surface water which in turn causes float pulsations and excessive valve movement.

(3) Fulcrums should be well lubricated and close attention given to the stuffing box. If this is too loose, the valve will chatter and if it is too tight, the valve will be sluggish and close suddenly.

Branford, Conn. G C W GOLEM

Ammonia in Brine

Answers to October Question 2

The Question

IT LOOKS *as if one of our brine tanks has a slight ammonia leak. Is there a way to determine the exact amount of ammonia present in the brine as a result of this leak? A 2-oz sample taken from the tank will turn pink when 3 drops of phenolphthalein test solution is added*—LMR

Suggests a Rough Check

THE SIMPLEST way to determine the exact amount of ammonia present in the brine is to send a sample to a commercial laboratory. Before doing this, however, some definite ideas may be obtained as to whether ammonia is actually present in the brine. LMR does not state whether he has a salt brine, a straight calcium or mixed calcium-magnesium brine, but

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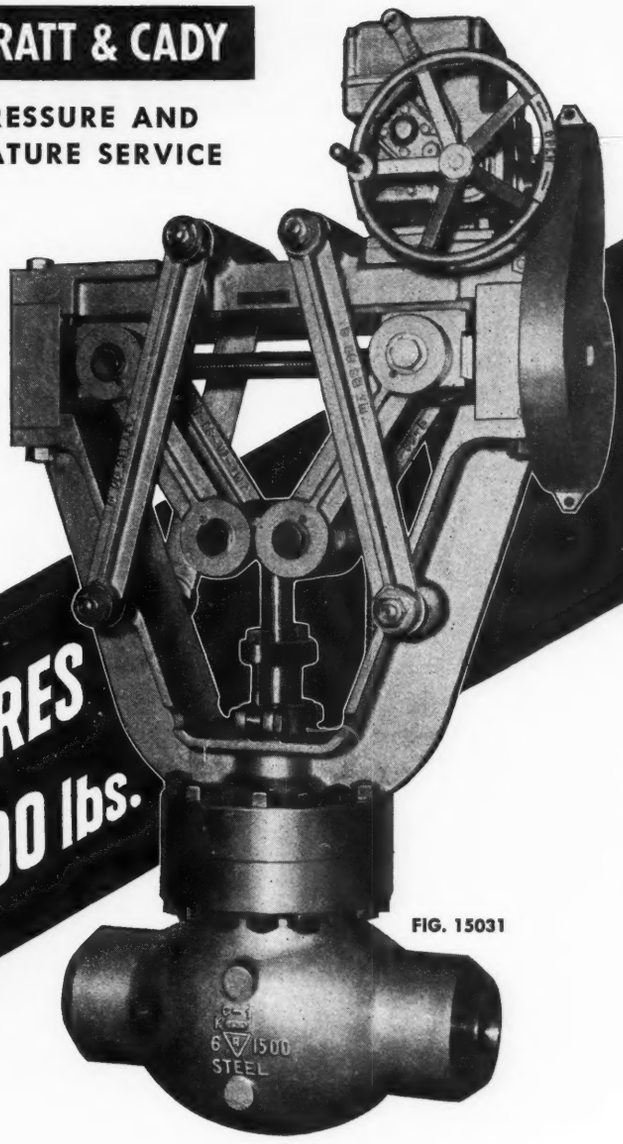

PRESSURES up to 1500 lbs.

TEMPERATURES to 950° F.

MOTOR-DRIVEN TOGGLE-OPERATED —IDEAL FOR GLOBE VALVE DESIGN

FIG. 15031

Another Stride Toward Lower K W Production Costs—due to *combined* specifications of this new globe valve.

Body of carbon molybdenum cast steel. Spindle of stainless steel. Stellite surfaced disc and welded-in seat ring. For 1500 lb. service up to 950°F. Toggle operation because the high ratio of mechanical advantage of toggle design increases as the closing position is approached—when a closing globe valve meets its greatest resistance. Motor operated for efficiency and convenience.

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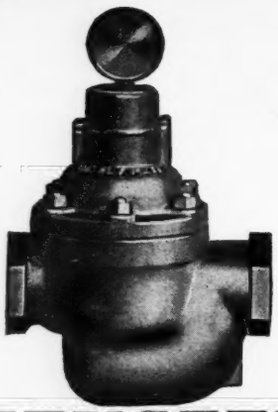
What's Your
LIQUID MEASURING PROBLEM?

The instruments described below have solved many problems where an accurate measurement of some "hard to measure" liquid was required. They may be just what you are looking for—let's get together!



HENSZEY
FEED WATER METER

While primarily designed for feed water, this accurate meter has been put to many different uses in various industries. "Hard to measure" liquids, such as Condensate, Hot Dirty Water, Free Running Chemicals, etc., have been successfully metered with this instrument. Check up in your plant—this may be the "out" you may have been unsuccessfully searching for. Send in your problem!

FLOW INDICATOR

Here is another item that was primarily designed for use in the Henszey Blowdown System, but has found uses in other fields. Indicates rate of flow of steam, water or other fluids. Special model meets all sanitary requirements for milk and other food fluids.

New literature available on these items.

HENSZEY COMPANY
DEPT. D-1 . . . WATERTOWN, WIS.

Also ask about

HENSZEY

CONTINUOUS BLOWDOWN — COMPLETE, AUTOMATIC BOILER WATER CONCENTRATION CONTROL — WITHOUT HEAT LOSS!

if ammonia leakage occurs with the latter, a white solid is formed which immediately indicates a leak. With salt brine, the addition of lime water to a sample will show presence of ammonia by formation of a white insoluble substance. If this fails to show ammonia, lime may be added to the sample. The odor of ammonia will be noticed if the mixture is heated, and there has been ammonia leakage.

If the above test reveals ammonia present, a crude method of determining whether the amount increases or not can be used. Dilute a few drops of sulphuric acid or storage-battery acid, and keep this solution as a reference. Take a measured amount of brine, about 2 oz, and add phenolphthalein solution. Add acid with a medicine dropper, counting the drops required to discharge the color. After a few days try the same thing again; if more acid is required there is a leak. The amount of leakage can be guessed at by the increased amount of acid required. Incidentally, if only one drop of acid is required, dilute the acid more to give a more accurate test.

Lakewood, Ohio J P SIMONS

Use Methyl Orange

AMOUNT of ammonia in brine liquor can be determined by titrating a weighed sample of the brine solution against a tenth-normal sulphuric-acid solution, using methyl orange as the indicator for the end point. The amount present is calculated as follows: Let A equal millilitres of acid used in titration, and B the weight of the sample taken, then

$$\% \text{ ammonia} = \frac{A \times 0.017 \times 100}{\text{sample wt. (grams)}}$$

If the result is desired in ounces per gal., multiply the percent of ammonia by 1.33 and by the density of the brine solution.

Standard tenth-normal sulphuric-acid solution can be purchased from any laboratory supply house and with a little practice, the end-point transition of methyl orange from yellow (alkaline) to a deep orange (acid) can be readily detected. Phenolphthalein can be used for a qualitative indication of the presence of alkalies but is not suitable for a quantitative test.

Philadelphia, Pa. C F KENNECK

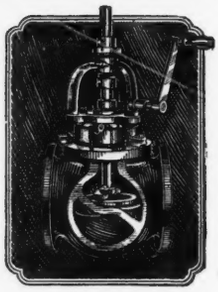
Test with Litmus

PHENOLPHTHALEIN cannot be depended on as a test for ammonia since its action is due to the alkalinity of ammonia, and it is possible that the brine itself may be slightly alkaline. For this reason phenolphthalein paper, or litmus paper, should be used. Instead of immersing the paper in the suspected brine, fill a drinking glass half full of brine and add a small amount of caustic soda. After allowing sufficient time for the caustic to dissolve, cover the glass with a strip of glass to the underside of which a piece of litmus paper has been attached by moistening the ends.

If the brine contains ammonia, the

DEXTER VALVE RESEATERS

for Globe Valves, Gate Valves, and Pump Valve Seats



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STOKERS
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Fig. 1513

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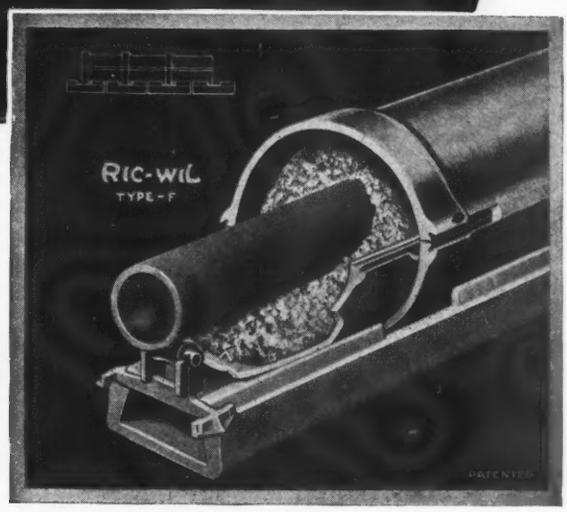
WHY RIC-WIL MEANS the ONLY real underground Steam Protection!



Every underground steam system today *claims* high efficiency. But you, as the one whose interests are at stake, must examine these claims in the cold light of engineering analysis. When you *take apart* the average commercial conduit system, and compare it, point by point, with Ric-wiL, what do you find? You find—in common with hundreds of engineers and heating experts —that Ric-wiL and only Ric-wiL can justify, by actual superiority of both design and materials, and by abundant post-installation tests, a consistent record of over 90% efficiency on the line. Structural stability of Loc-liP joints and interlocking sections are found in no other system. Moisture repellence and insulating qualities of Dry-paC Asbestos are found in no other system. The Ric-wiL principle of drainage is an outstanding feature. With standard weight Tile, Super Tile, Cast Iron, and pre-built Unit Steam Main, and with a wide choice of insulation, Ric-wiL offers types and prices for every purpose.

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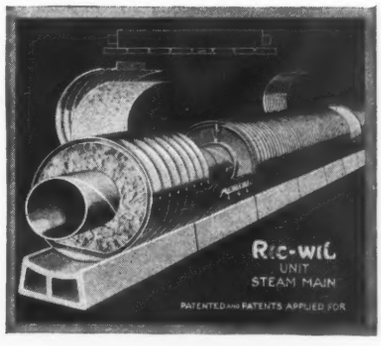

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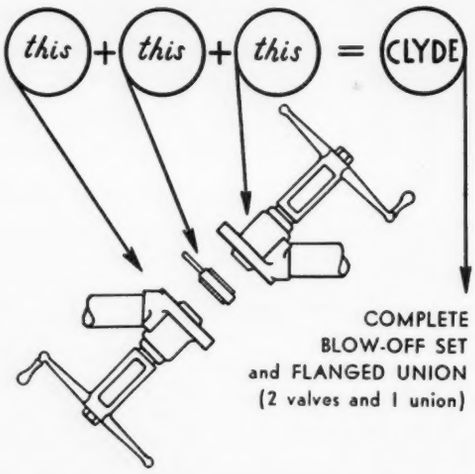
of all
CLYDE
VALVES



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BLOW-OFF SET
and FLANGED UNION
(2 valves and 1 union)

Two specially designed flanges with standard bolt centers securely clamp the double seat ring in place; each flange forms a valve body — that's all there is to it! Either flange is removable with its pipe section making BOTH of the valves AND the seats completely accessible. The non-rotating stem is provided with a wrench fit for grinding valve while in operation. Massive, large diameter lifting threads insure a lifetime of constant use. Extra deep stem packing requires minimum upkeep. All materials and principles are time-tested where long experience has dictated their best suitability.

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CLYDE DIVISION
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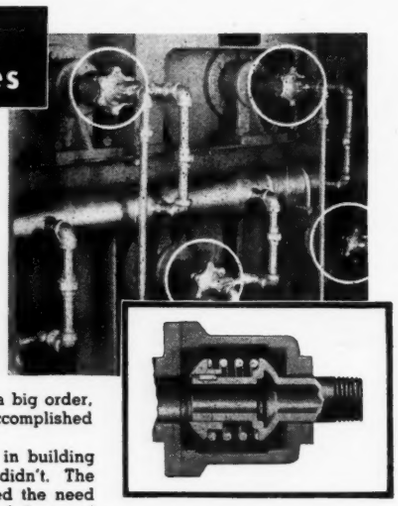
Once stuffing boxes were just stuffing boxes

—but Johnson Corporation made a science of them



● A few years ago The Johnson Corporation stepped forward to end the miseries that had come to be taken for granted in maintaining the stuffing boxes and "steam fits" used on machines with rotating steam filled drums or cylinders.

One of the troubles with the old-style boxes was the packing. Another was the endless oiling. Still another was the problem of keeping them in adjustment. The designing of a joint that would be packless, self-oiling, self-adjusting and self-aligning was a big order, but we filled it. The ingenious design that accomplished this is briefly described opposite.

We might have coasted on the laurels won in building a mechanically superior rotary joint, but we didn't. The many installations of this better joint uncovered the need for better methods of draining the cylinders and drums of the machines to which they were applied. This led logically into joints with syphon-pipe drainage in which the condensate is removed through the same joint that admits the steam.

The second step was just as important as the first. We had not only ended the stuffing box troubles; we had also stepped up the efficiency of the machines to which Johnson Joints were applied. As a result hundreds of textile mills, paper mills, rubber plants and other plants using a rotating-drum machinery have found that they can't afford *not* to use the Johnson Rotary Pressure Joint.

Right now is the time to write freedom from stuffing box troubles and increased efficiency into your 1939 operating records—with Johnson Rotary Pressure Joints.

Write for latest bulletin

You SAVE steam, power, time—

The basic elements of the Johnson Joint are illustrated above. Pressure is retained by a pressure - sealed special carbon - graphite ring. Since the seal is varied by the pressure, the joint is self-adjusting. Oiling is eliminated because the carbon-graphite is self-lubricating. The ball and socket form takes care of angular misalignment, and an annular space around the threaded member takes care of lateral misalignment. There are many variations of the head for special applications.

The Johnson Corporation
865 WOOD STREET, THREE RIVERS, MICH.

paper will turn pink under the action of the ammonia fumes. Warming the brine will hasten the action. If the paper is not affected after four or five minutes, the brine contains no ammonia. The amount present can be approximated by determining the time elapsing before the paper changes color. As a guide, a known amount of ammonia may be added to a given weight of pure brine and the time required noted.

Hamilton, Ontario S G PATERSON

Nessler's Solution Best

LMR'S TEST of brine with phenolphthalein shows a high degree of alkalinity and points to ammonia leakage. Alkalies in salt and water used in mixing brine will also cause alkalinity and therefore the phenolphthalein test will not reveal the exact amount of ammonia. Nessler's solution is the best indicator for ammonia. Several drops added to a sample of brine will turn yellow if a trace of ammonia is present and deep brown if there is any quantity of ammonia in the brine.

Reliable diagnosis and safe corrective treatment of brine, if necessary, suggest the use of a hydrogen-ion indicator. Inexpensive comparator sets are available and tests can be made without a knowledge of chemistry. In tanks with galvanized ice cans, brines ranging in pH value from 7.8 to 8.2 will protect surfaces. If galvanizing has been destroyed, pH values ranging from 9.0 to 9.5 will provide maximum protection to iron and steel surfaces. Cases of excessive alkalinity may be corrected by slowly adding sulphuric acid to the brine near agitators. Samples of brine should be tested frequently until the correct pH value is reached. If heavy doses of acid are required, it is evident that there is a serious ammonia leak and repairs should be made at the first opportunity.

Fresno, Calif. E H CARLSON

Several Methods Possible

AMOUNT OF AMMONIA leakage can be estimated by measuring the quantity of standard sulphuric-acid solution required to discharge the pink color after the addition of the phenolphthalein indicator. Assuming that all alkalinity is due to ammonia, each cc of fiftieth-normal acid is equal to 1.7 ppm of ammonia, if a 100-cc sample of brine is used. If a leak is suspected, a series of tests will determine the rate of leakage.

Ammonia can be more accurately determined by (1) adding caustic soda solution to a measured sample of brine, distilling the ammonia into a measured amount of standard acid solution, and determining the amount of acid not neutralized, or by (2) diluting the brine with ammonia-free water, adding Nessler's reagent and observing the color developed as compared to previously prepared standards. However, these methods require equipment and experience not usually available to the plant operator.

A high ammonia content in brine will quickly dissolve zinc ice cans or other

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ONE athlete on a team usually *stands out*, captures your attention, wins the cheers of the crowd. In hockey, this man seems to be everywhere at once—but you keep your eye on him, for he's got something the other players haven't got . . . he's tougher, faster, more dependable.

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THE GARLOCK PACKING CO., PALMYRA, N. Y.

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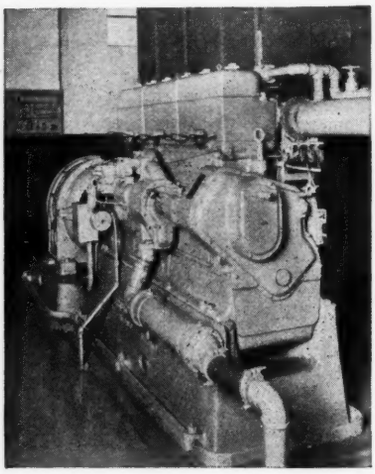

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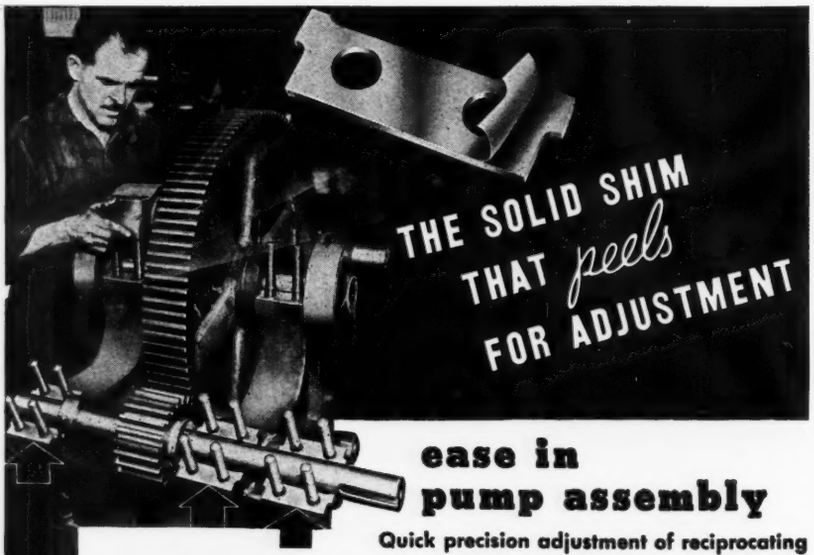

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Precision adjustment **SHIMS**

galvanized surfaces in the system. However, if the zinc is all gone anyway, the brine can be saved without damaging iron and steel surfaces. If this is to be done, 5 lb of chromic acid should be added for every 1000 cu ft of brine, repeating once or twice a season depending on how rapidly the yellow color fades.

Springfield, Ill. K M HOLADAY

Exact Determination

THE MOST DEPENDABLE method to determine the exact amount of ammonia in a solution is the distillation method. Apparatus needed includes a vertical condenser arranged so that the distillate shall drop directly to the receiving vessel, and Nessler tubes. The following reagents are required: (1) ammonia-free water. (2) Nessler reagent. This is prepared by dissolving 50 gm of potassium iodide into 35 cc of cold ammonia-free water, and adding a saturated solution of mercuric chloride until a precipitate persists. Add 400 cc of 9N sodium hydroxide, dilute to one liter, allow to clarify, and decant.

(3) Standard ammonium-chloride solution. Dissolve 3.818 gm of ammonium chloride in ammonia-free water and dilute to one liter. From this stock solution prepare a standard solution by diluting 10 millilitres to one liter with ammonia-free water. One ml contains 0.01 mg of nitrogen equivalent to 0.01288 mg of NH_4. (4) M/2 Phosphate buffer solution. Dissolve 14.3 gm of monobasic potassium phosphate (KH_2PO_4) and 90.15 gm of dibasic potassium phosphate ($K_2HPO_43H_2O$) in sufficient distilled water to make one liter of solution.

First step is to free apparatus of ammonia by boiling distilled water until distillate shows no trace of ammonia. Take 500 ml of sample, add 10 ml of phosphate buffer solution and distill at a rate of 6 to 10 ml per minute. Collect the distillate in four 50-ml portions in Nessler tubes. Prepare a series of Nessler tubes containing various volumes of ammonium-chloride solution diluted to 50 ml with ammonia-free water. Nesslerize the standards and the four portions of distillate by adding 1 ml of Nessler reagent to each tube. Allow tubes to stand for about 10 minutes and compare the colors produced. The sum of the readings for the four portions is equal to the number of mg of ammonia in the original volume of the sample distilled.

Monsanto, Ill. MARCUS COOK

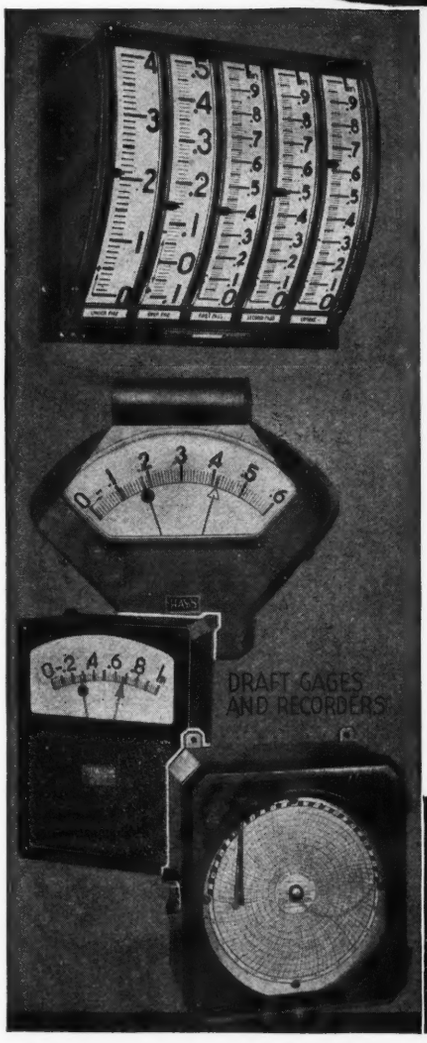
Stop Leak First

IF THERE is an ammonia leak in LMR's brine tank, the first thing to do is to find the leak and stop it; otherwise, he will not only lose ammonia at 17 cents per lb but all the litmus and phenolphthalein will only tell him that things are getting worse and in time, the noses and eyes of everytone in the vicinity will discover that fact without the aid of any chemistry.

If the leak has been stopped a quantitative determination can be made by any competent chemist, but it may not be

THIS DEVICE Revolutionized FURNACE DRAFT MEASUREMENT

The feature of the Hays Dry-Type Draft Gage mechanism is the slack-leather diaphragm. It is made of colon leather and is practically identical with the "gold beater's skin" of ancient times. It is unbelievably tough yet remains pliable in use over many years. It is connected to a simple calibrating spring that gives positive accuracy to draft measurements over a wide range. This use of a diaphragm in a draft gage was pioneered by Hays and is now widely imitated.



BEFORE the advent of the Hays Slack-leather diaphragm the draft gage was a cumbersome, breakable, leaky, complicated contraption that had to be leveled to be read.

The introduction of the Hays mechanism did away with all liquid, glass tubes, inverted bells, counter weights, oil seals and involved linkages. As illustrated above, the Hays mechanism is simple in design, small in size yet so well made of such fine materials that it gives years of perfect service under the strenuous conditions of the modern boiler room.

Because of its design and construction it can be placed in any position and still give hairline accuracy. This makes possible its use in a variety of gage types some of which are illustrated—the "V" type for easy reading above eye level, "F" or fan type with the extra large scale and long distance visibility; and the "D" type with flat scale in varying combinations for pressure, suction and differential applications.

One or more of these types is needed in every boiler room to determine what draft is being developed, what condition the fuel bed is in, whether or not the baffles are in good shape, whether the setting is tight or leaking, and furthermore most boiler rooms ARE equipped with Hays Draft Gages. How about your own? Complete information contained in Publication No. 37-294.—Write to Dept. 1-1-9 for it today.

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Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

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YARNALL-WARING COMPANY
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necessary to go to this trouble. Unless the brine contains so much ammonia that it will attack copper or brass fixtures, there is no need to worry. Sometimes a calcium-chloride brine made with impure calcium chloride may contain magnesioum chloride in solution. If that is the case, considerable sludge might form if ammonia enters the brine and clarification measures may have to be taken to get rid of it.

Old Bridge, N. J. A J LUBELEY

WHY THIS RULE?

Safety-Valve Springs

IT IS NOT difficult to visualize what would happen to a piece of steel bent back and forth twenty or thirty thousand times. Now consider a carefully heat-treated steel spring given this same treatment, but under a wide and rapidly fluctuating temperature change, and one can picture the conditions under which safety valve springs operate. In one rather unusual but not exceptional case, the spring in a safety valve is known to have flexed under over sixty thousand "pops", and it is still in satisfactory working order.

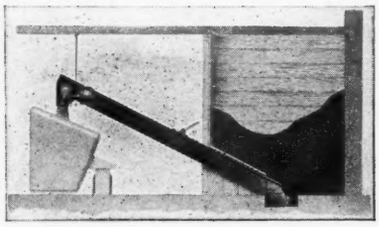
"Wear" on the spring is usually not manifest until its late stages, and then only in a metallurgical phase—fatigue. During the many stress changes from flexure at various temperatures, the crystalline structure of the metal undergoes an infinitesimal but progressive change. Anything may happen after this change reaches the fatigue limit. The latter term is arbitrary and must be considered as an average, as microscopic variations of the initial crystalline structure of the spring steel may bring about wide discrepancies in a set fatigue limit.

The spring may just "grow weak", and on compressing it cold with coil-to-coil contact for ten minutes, a permanent set of 10% or more of its free length will take place. Note that the rule gives a limit of 1% for the permanent set after this test. Here is an arbitrary figure that is not always 100% correct, but it is an average found and checked between practical experience and formulas, and it is a safe rule to follow.

When the permanent set exceeds 1%, one can feel quite safe to assume that the fatigue limit for the spring has been reached. The spring is weak, popping at the same pressure as originally set cannot be relied upon, and intercrystalline cracks and breakage of the spring are possible.

One may ask, "when should this test be made?" That is a matter of judgment based on (1) the estimated number of pops the spring has operated under; (2) whether it has been exposed to excessively high temperatures, and (3) whether the popping pressure is not uniform. For the first factor there is no set answer. A fair estimate might give 15,000 pops as a good time for the test. If either (2) or (3) occurs, it is advisable to make the test immediately. Naturally, this compression test should never be made except on a cold, idle boiler.

Quit Filling Your Stoker Hopper by Hand—Do It Automatically



A labor-saving device that is easy to install and can be adjusted to fit practically any condition or any stoker hopper. Distance from coal pile only governs length of the loader . . . capacity up to 10 tons of coal per hour . . . simple and safe to operate . . . nothing to maintain . . . right or left-hand operation . . . suspended from ceiling or supported by stand from floor . . . equipped standard with 1½ H.P. motor. Write for complete details.

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